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DOCTORATE IN EDUCATION



**The Nature of Assessment, its Validity and its
Relationship with Learning on BTEC (NC)
Courses in Engineering Principles.**

Curriculum & Assessment.

April 2002.

**The Nature of Assessment, its Validity and its
Relationship with Learning on BTEC (NC)
Courses in Engineering Principles.**

Doctor of Education (Ed.D).

**Christopher Edward Wakeman.
M7067546
April 2002**

Abstract.

This case study investigates the nature of assessment, its validity and its relationship with learning on the Business Technician Education Council (BTEC) National Certificate (NC) courses in engineering principles. The study took place within the No. 1 School of Technical Training at Royal Air Force (RAF) Cosford, which is an accredited centre for BTEC (NC) and Higher National Certificate (HNC) awards in engineering based subjects. The No. 1 School of Technical Training has approximately 2000 students working towards BTEC awards at any one time.

The principal aims of the study were to identify the essential characteristics of the assessment strategy for BTEC (NC) courses at RAF Cosford and to evaluate its validity. There was a particular emphasis on the appropriateness of the assessment procedures identified, and the implications for fair and impartial assessment, particularly with regard to learners with different individual learning styles.

Methodologies used to investigate the specific questions within this research transcend the theoretical divide between positivist and interpretative ideologies, giving the study an eclectic character that combines quantitative and qualitative techniques. Specific procedures employed during the study include documentary analysis and semi-formal interviews during the early part of the enquiry, followed by statistical mapping and probability tests as the work progressed. Honey and Mumford's (1986) learning styles questionnaire was used to identify individual learning styles in a sample of students, and this was supplemented by a new scoring system that strategically placed each learner on a polar graph depending on the individual learning style identified.

The findings from the study revealed a complex system of assessment for each BTEC unit investigated and this has been described as 'dendritic' in nature due to its tree-like structure when formed into a flow diagram. Concerning validity, there are a number of recommendations for improvement. My conclusion in this area is that although validity was at acceptable levels in

certain respects, poor question design, inadequate criteria and lack of an experiential approach reduce validity overall. The most significant issue regarding validity probably relates to whether different learners are in fact being assessed on the same cognitive domains during summative assessment, as there is strong and compelling evidence within this study that certain learners are disadvantaged by particular types of assessment due to their individual learning style. This 'potentially damaging side effect' has implications for reliability and validity, as individual learners may experience certain assessment procedures in different ways. This could alter the degree of difficulty experienced by learners with a particular learning style, and this problem may be augmented by the way that data is presented within a test item. There is further evidence that certain knowledge types may also be more 'reactive' than others. This evidential claim is based on research that mapped assessment performance by the different learning style groups to pre-defined knowledge types. Though the evidence is convincing, the relative limitations of the sampling must be taken into account in drawing these conclusions.

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Chapter 1: Introduction.

Assessment and its validity has been a topic of great educational debate during the past 20 years. Much of this debate has focused on schools with a particular emphasis on the national curriculum and the types of assessment that would best support this development for pupils between the ages of 5 and 16. In further education there has also been much discussion, particularly concerning the assessment of General National Vocational Qualifications (GNVQs), where great emphasis has been placed upon a 'criterion referenced' approach that is in stark contrast to traditional methods that are based on examinations and practical phase tests. The Business Technician Education Council (BTEC) offer awards at National Certificate (NC) level and Higher National Certificate (HNC) level. These qualifications evolved from the Ordinary National Certificate (ONC) and Higher National Certificate (HNC) and appear to have been largely unaffected by developments elsewhere, continuing to employ assignments and end of module examinations as their primary means of summative assessment. BTEC themselves offer little advice regarding assessment other than to suggest ways of assessing common skills, and to provide a few general guidelines for assignment design and grading. Furthermore, with the exception of a small number of studies, this area of educational research appears to have been largely ignored by contemporary researchers. This research study will attempt to re-dress the balance and provide an insight into the nature of assessment on BTEC (NC) courses, its validity and its relationship with learning.

Focus and Rationale.

Most educational research into assessment validity has as its focal point the issues of construct, content or the predictive ability of assessment. Few studies have moved beyond these concepts to consider assessment validity and its relationship with learning. This study aims to investigate whether assessment performance is influenced by the individual learning style of a student. This is an issue that has implications for 'impartiality' and 'equality' and as a consequence, may have an effect on assessment validity.

Approximately 25 years ago, Kolb (1976) alerted us to the concept of individual learning styles and produced a 'learning styles inventory' for the purpose of

identifying style preferences for individual learners. His work was developed by a number of researchers¹ including Honey and Mumford (1986), who produced their own system for identifying individual learning styles. If we accept Kolb's idea that individuals adopt a particular style to assist their learning, then it seems sensible to suggest that this has repercussions for assessment. Certain types of assessment may suit one style of learner more than another, advantaging some and disadvantaging others, and though this remains to be proven, if this is the case then there are implications for assessment validity.

At Royal Air Force (RAF) Cosford where this investigation is focused, we train BTEC (NC) students as they progress towards an award in aeronautical engineering. As a Burnham Lecturer I am involved in teaching the academic units which make up the aeronautical engineering qualification and which include mathematics, engineering science, materials science and electrical principles. The aim of this study is to investigate the nature of assessment on the BTEC (NC) academic units and to focus on a range of issues regarding the validity of the assessment strategy. This includes not only the usual concepts of construct and content validity, but also, issues relating to cognitive preferences, their impact on validity and the appropriateness of certain types of assessment instrument with regard to different types of learner. To achieve these aims, this study is broken down into five main areas, each of which forms a distinct, but interrelated strand of research. The graphical representation included as figure 1.1 overleaf defines the theoretical framework for the study and shows the relationship between the five strands of research.

The Research Paradigm.

The debate concerning the methodologies best suited to different types of educational research focuses on quantitative and qualitative procedures, with one school of thought insisting that the two philosophies are separate and distinct from each other, while the other recognises the potential of combining the two. This piece of research comes under the latter category, and strives to combine positivist and interpretative beliefs into an eclectic model that benefits from the best practice of each. The rationale for this approach will be explained in detail later in this report, it is appropriate to note at this point, however, that in adopting this stance a number of issues were considered to

¹ See literature review later in this report.

The Theoretical Framework for the Five Strands of Research.

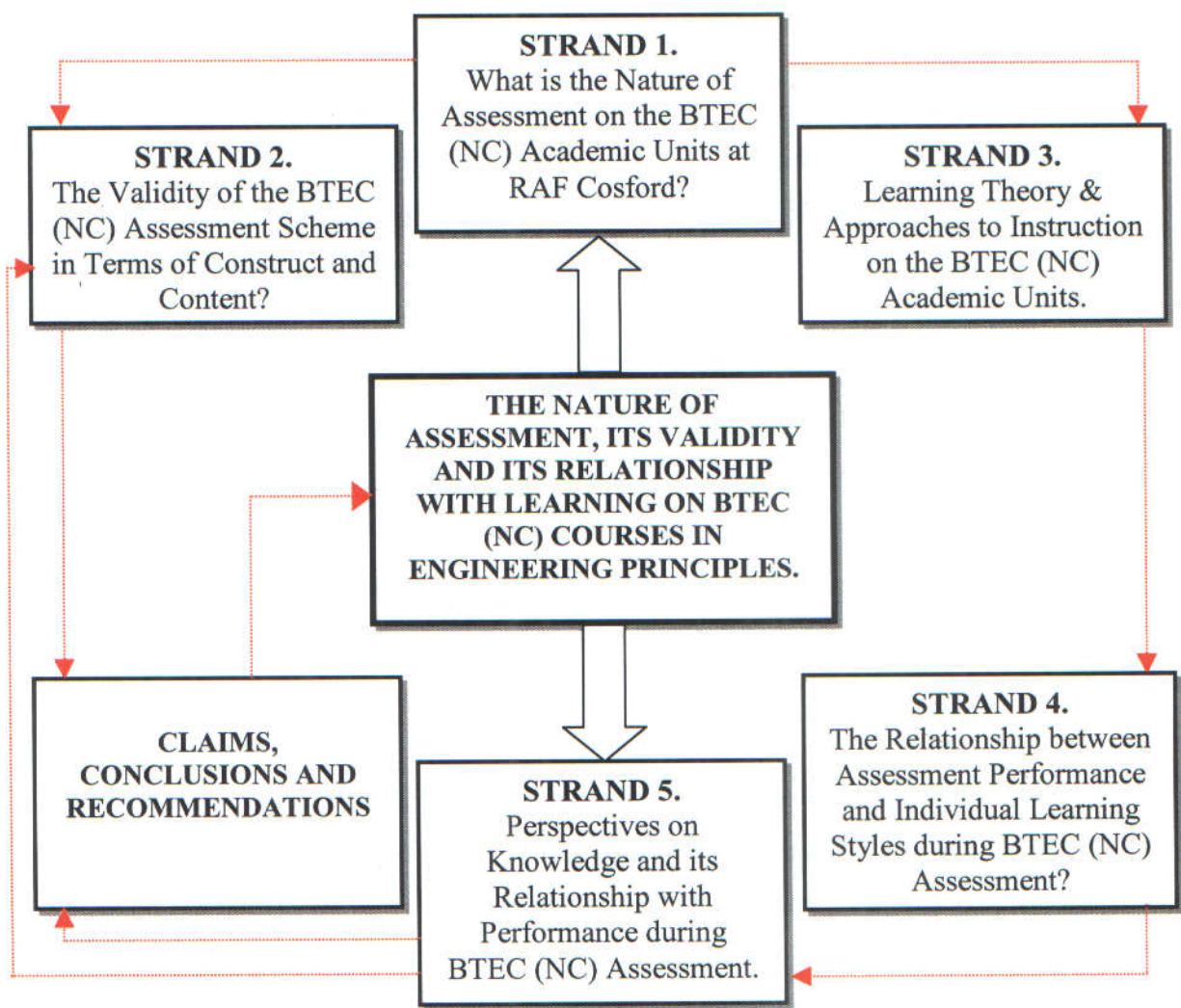


Figure 1.1

be of fundamental importance. Firstly, the type of data that was available to me and that already existed, included both documentary and statistical data, all of which provided important evidence for this study. The analysis of this material required the application of a range of techniques that transcend the theoretical divide. Next was the issue of ‘objectivity’. I tend to agree with those researchers who feel that objectivity is easier to defend by reference to the type of data normally associated with quantitative research. Even so, I am in little doubt as to the value of interpretative techniques as a tool to probe for meaning, understanding and process, concepts that may prove to be out of reach when applying quantitative techniques. This then, is an investigation that may be usefully described as an ‘eclectical case-study’. It draws on theories and

techniques that rise above the positivist/interpretative divide, seeking out the best practice from each, to form a coherent approach to modern research.

Audience.

The audience for this investigation will be wide-ranging and diverse. The study has as its central focus, RAF Cosford, which is accredited by BTEC for the award of (NC) and (HNC) qualifications in aeronautical engineering. RAF Cosford is now the largest RAF training station in the United Kingdom with over two thousand trainees working towards BTEC awards at any one time. Part of the audience for this research will exist at various levels within the RAF Cosford institution and the wider field of RAF training worldwide. This audience will be reached through submission of this report to interested parties and follow up briefings or presentations where necessary. At this level, I envisage implications and recommendations for the appropriateness of certain types of assessment and the design of assessment instruments at institutional and departmental level.

Beyond the RAF there will be a wider audience at national level that will include policy makers within the awarding bodies such as BTEC and the City & Guilds of London Institute (CGLI). The Qualifications and Curriculum Authority (QCA) who have been appointed to design the National Qualifications Framework (NQF) will also have an interest as assessment, its validity and its relationship with learning will form a focal point within their work. It is my intention to make this report available on a dedicated web site so as this audience may be reached. Finally, there is the international audience within Europe and beyond. Other countries, including Australia, New Zealand and South Africa, are already well advanced in their plans for a national qualifications framework and any implications or recommendations arising from this study will be of relevance to them. A valid, reliable and impartial assessment policy is a vital ingredient for any such scheme, and this investigation seeks to develop and build on the growing body of knowledge in this field. The dedicated web site will again provide access to this audience.

Chapter 2: Literature Review.

Introduction.

Figure 1.1 in the previous section of this report shows five main areas in which this study is located. These are – the nature of assessment or the essential characteristics of the assessment strategy under investigation, the construct and content validity of the instruments which comprise that strategy, the theories of learning that underpin the BTEC (NC) academic modules, the learning style of the student and its impact upon assessment and the relationship between knowledge, assessment and individual learning styles during summative assessment. The literature review that follows is structured around this theoretical framework. It is broken down into five main sections each of which maps directly to one of the strands of research identified on figure 1.1. This is not to suggest that the five areas are not connected. Interrelationships between the different strands will be explored when the findings are presented and during the discussion of results later in this report. It does, however, provide a structure for presenting the literature review and proved extremely helpful in organising searches during the initial phase of this study.

Part 1: What is the Nature of Assessment on the BTEC (NC) Academic Units at RAF Cosford?

If we are to consider the nature of assessment, then we must focus our attention upon the essential components of assessment and begin to develop a clearer picture of how assessment procedures influence and alter the teaching/learning situation. Harris & Bell (1996) list what they describe as "bipolar constructs" (Page 97), and go on to suggest that analysis of these, and related issues: "form a valuable way of discussing factors involved in the choice of an assessment technique or, in the analysis of a technique already in use" (Page 98). The bipolar constructs that they identify are reproduced overleaf with more detailed comments to follow:

INFORMAL	FORMAL
FORMATIVE	SUMMATIVE
PROCESS	PRODUCT
CRITERION REFERENCED	NORM REFERENCED
INDIVIDUAL FOCUS	GROUP FOCUS
CONTINUOUS	END POINT
LEARNER JUDGED	TEACHER JUDGED
INTERNAL	EXTERNAL

(Harris.D. & Bell.C. 1996 page 98)

So what importance do Harris & Bell's bi-polar constructs have in relation to the assessment of BTEC (NC) engineering principles, and indeed, what is their relevance to this study? Certainly, as the authors suggest, they seem to summarise the main characteristics which may be attached to different assessment tools when selecting or evaluating approaches to assessment. Furthermore, they may prove useful when attempting to establish whether an instrument has construct validity, providing a basis for the design of an evaluation schedule. It seems apparent, that in the context of BTEC (NC), some of the constructs have more significance than others.

BTEC/EDEXCEL have been great advocates of curricula that mix and integrate process and product objectives (see BTEC 1992), hence, one would expect an assessment policy that is designed to support the teaching of BTEC courses to reflect this philosophy. My own experience of teaching BTEC (NC) engineering principles, alerts me to the fact that all the assessment procedures in current use are criterion referenced to some degree. Consequently, in identifying the essential characteristics of

the scheme, and later, in attempting to establish its validity, this construct will undoubtedly take on extra significance. What we are primarily concerned with at this stage, however, are definitions. If we are to identify the essential characteristics of the assessment policy under investigation, we must be able to place each instrument in its strategic position and define its basic constructs. Harris & Bell's work provides a framework for achieving this objective, and consequently provides a good starting point for this initial phase of the literature review.

Process or Product: The Evolution of Common Skills Assessment.

It seems fair to suggest that product and process are closely related, as Harris and Bell state: "There is unlikely to be any product without process" (1996 page 100). They go on to note that much assessment, particularly in further and higher education has traditionally involved the judgement of some product, rather than the process through which that product is evolved. It is apparent that developments over the last fifteen years have attempted to redress this balance, and it is now widely recognised that in education, as in other areas of life, processes are of great importance. As Harris and Bell acknowledge:

"Assessing these processes can help the teacher and other learners come to know each other, to better understand each others needs, to minimize any mismatch between teaching and learning."

(Harris.D. & Bell.C. 1996 page 105)

Reece and Walker (1995), define the 'process model' as having two distinct features:

"i) A focus on student activities, and

ii) The teaching and assessment of transferable skills which are common to a number of subject disciplines."

(Reece.I. & Walker.S. 1995 page 239)

The first point "a focus on student activities", is a little vague though one assumes they mean that rather than concentrating on the end result, we should be focusing on the students' means of achieving it. The process of reaching the end product may vary, though there are certain features that should be common to all students and which can be formalised. Consider for instance, an objective that requires a student to 'produce a

stress/strain graph from given data'. Obviously, the end product would be the graph and we could look at it and possibly assess whether it had been done correctly. At the end of the exercise we could say either yes it has, or, no it hasn't. But what if it hasn't? If we have failed to focus upon the way the student approached the problem we have nowhere to go next, whereas if we have evidence of the process that's been used, or if we have defined it with process objectives, we should be able to ascertain where things went wrong and where to concentrate our attention.

Even so, Reece & Walker do not advocate the process model per se, suggesting that successful curricula - "will benefit from the inclusion of a mixture of process and product objectives." (Page 241). As noted previously, BTEC/EDEXCEL have been great advocates of curricula that mix and integrate product and process objectives and since the autumn of 1986, courses have evolved where the assessment of 'process' and the development of 'common skills' has become a major part of the overall assessment strategy. The identification and analysis of the essential characteristics of this approach form an important part of this study and we may begin by evaluating the BTEC definition of common skills which is reproduced below:

"Transferable skills which play an essential role in developing personal effectiveness for adult and working life, and in the application of specific vocational skills."

(BTEC 1992 - page 2)

It is evident that the BTEC definition has similarities with Reece & Walker's description of the process model which is quoted above, hence, it would seem apparent that in assessing common skills we are concerned with assessing the part of the process that will ultimately lead to a desired product. They go on to prescribe seven distinct headings for the assessment and reporting of common skills with each heading broken down into precise outcomes with skill area aims, performance criteria and range statements to assist in the assessment process. An example is included as appendix (A) at the rear of this report.

Cashian (1995) examined the BTEC approach to common skills in the context of higher education. He concluded that the assessment of such skills could take various

forms and he identifies two methods in particular that may be deemed suitable. He states:

“The assessment could be merely formative, the Performance Criteria used as a guide to the student as to the behavioural characteristics that are desirable, and for feedback on performance, but with no formal grading of skills as a separate entity from the subject content.”

(Cashian.P. 1995 Page 20)

He goes on to note:

“An alternative approach is the purely competency-based 'can or cannot yet' method as used in NVQ's and GNVQs. The outcome describes the students expected behaviour. The student claims the outcome by presenting evidence that satisfy the performance criteria against which a successful achievement of the outcome is judged. In effect the outcome becomes a hurdle that must be jumped in order to progress.”

(ibid Page 20)

Cashian suggests that BTEC take the competency-based approach described above a stage further noting that in their common skills criteria:

"The outcome defines the basic hurdle, however a student is then graded on how well the outcome is achieved - achieving the outcome is deemed a pass, performance beyond this basic level can be graded merit or distinction. In order to pass a BTEC course students must have achieved at least a pass grade in all 18 outcomes.”

(ibid Page 20/21)

In addition to the above observations, Cashian also acknowledges the student centred approach to common skills assessment that BTEC place at the centre of their philosophy. He suggests that this is reflected by their 'implementation guidance' issued in May 1992 that outlines 5 models of common skills (CS) delivery. He summarises these as follows:

- A: CS are fully integrated and are the focus of the programme. 'The programme belongs to the learner and the tutor in a facilitator or manager of learning'.**
- B: CS integrated within most of the modules. Students involved in the process of developing and monitoring CS.**
- C: CS assessed principally via the programme of integrated assignments.**
- D: CS assessed only via the programme of integrated assignments.**

E: CS delivered and assessed separately from the main programme and is teacher centred.

(Cashian.P. 1995 Page 22)

It seems evident as we move down the list from model A to model E, that the extent to which skills assessment is integrated into the course units decreases. In fact, by the time we reach model E, common skills are delivered formally and taught separately from other modules. This approach presumably would require extra time to complete the course as a whole.

In essence, the assessment of common skills appears to focus on process, and the essential characteristics of common skills assessment as Cashian sees it revolves around the 18 outcomes identified by BTEC, which are grouped into 7 skill areas. Each outcome is supported by performance criteria that specify the behavioural requirements a student must demonstrate and range statements outline the situations or contexts in which the outcomes must be demonstrated. Thus, what we have is a framework for common skills that helps the student to claim each skill as they progress through the course. The skills remain the same for all BTEC courses, though the level at which each skill must be achieved increases as the student progresses from BTEC (First) through BTEC (NC) and on to BTEC (HNC).

Criterion Referencing: The Essential Characteristics.

The gradual transition in education from an assessment system that was predominantly norm referenced to a scheme that is largely based upon criteria has fuelled a lively and often aggressive debate that is centred upon the relative advantages and disadvantages of each approach. This study does not attempt to enter this debate and accepts that both approaches may be appropriate in differing contexts. It is apparent from my own experience of teaching on BTEC (NC) courses, however, that BTEC have moved wholly towards criteria as a basis for assessment. Consequently, if we are to explore the essential characteristics of BTEC assessment, we must first understand what provoked this shift and attempt to understand its implications. To begin this process, we must consider the *characteristics* of the two contrasting strategies, a process that we may begin by considering two definitions:

"Norm referenced assessing aims to compare the achievements of the learner with those of other learners.

Criterion referenced assessing aims to assess the learner by comparison

with some pre-determined or negotiated criteria (e.g. a competency or a specified attainment target)."

(Harris.D. & Bell.C. 1996 Page 101)

Though the trend over the past 20 years or so has been towards criterion referencing as a basis for assessment, some educationalists such as Simpson (1990) doubt whether the conditions for learning have been improved as a result. Her main concern seems to focus upon the narrow view of learning that such a system implies and the constraints it places on the learning experience. Her work is reviewed further on the following page of this report.

Futcher (1987) briefly touches on the subject as part of a larger discussion regarding validity and reliability. The implication here is that the choice between norm and criterion referenced approaches will ultimately affect the construct validity of the assessment being carried out. He reminds us about the theoretical basis of norm referenced testing which he suggests is based upon traditional statistical analysis of tests and test results. In short he says:

"Its theoretical foundation is one simple assumption: various skills which are measured are equally distributed throughout the population. In each skill it is inevitable that some will be excellent, some will be poor, and the majority will be 'roughly average'. I make no judgement as to whether this is true or not, but if an educator believes this to be true, then there is no reason to abandon norm referenced tests."

(Futcher.G. 1987 Page 262)

With regard to criterion referencing he seems a little sceptical. He outlines the precision which norm referencing offers us in terms of 'placing' students, and goes on to note that the switch to criterion referencing offers only a 'pass' or 'fail'. In other words those students who can, and those who cannot. Those who fulfil the criteria and those who don't. He also outlines reservations about how criteria are set, suggesting that such assessment methods are often over concerned with content while construct may be overlooked.

Butterfield (1995) makes a detailed study of the issues surrounding norm and criterion referencing commenting not only upon their educational merits but also looking closely at the evolution of criterion referenced testing over the past 40 years. Though the work revolves primarily around the role of criterion referenced assessment within the National Curriculum, she explores many more general aspects of criterion

referenced approaches and identifies several models that fall under this banner. A particularly interesting debate concerns two models that she describes as the 'state' model and the 'continuum' model, both of which relate to a 'minimum proficiency' in attaining mastery of a skill or concept. The difference appears to hinge upon the interpretation of mastery as the 'state' model distinguishes only between mastery and non-mastery, while the 'continuum' model advocates the notion of - "stages or degrees of mastery" (Page 95). This suggests a requirement for criterion levels and as she goes on to note introduces quite different expectations from the more simple forms of criterion referenced approaches. This will become an issue within this study as it has implications in a number of areas that are pertinent to this investigation.

One of the main concerns raised within this debate, revolves around the concept of professional judgement, and as a consequence, subjectivity. If we take the 'state' model, here the assessor is required to exercise judgements as to whether enough 'mastery' has been achieved to merit a pass. As Butterfield notes, this system relies - "heavily upon some definition of mastery." (Page 96). The 'continuum' model increases the problem. Now we have levels of mastery, and therefore more judgements to be made. In other words, neither model provides the "technically precise" system that this type of approach requires.

Simpson (1990), suggests that the whole concept is:

"rooted in a simplistic model of teaching and learning."

(Simpson.M. 1990 Page 174)

She goes on to note that the assumption underlying such approaches is that:

"pupils only learn what they are explicitly taught, and
if they have not learned what they are taught, they haven't
learned at all."

(ibid Page 174)

She concludes that regardless of the potential that criterion referenced assessment holds in terms of formative assessment, when its used for summative purposes as it more often is, it amounts to little more than an alternative way of "sorting pupils". (Page 181).

The BTEC Approach.

So what is the BTEC philosophy regarding criterion referencing? A review of their current literature produced for professional development and training (BTEC/EDEXCEL 1998), leaves us in little doubt that criterion referencing is an essential characteristic of all their assessment schemes for F/NC & HNC courses. Though they don't prescribe an assessment policy for their courses per se, they do dictate the underlying principles for assessment design that all accredited centres are expected to employ. The professional development and training notes distinguish between 'assessment criteria' and 'grading criteria' with respect to assignment design (Page 27). Their definition of the two different types of criteria remind us of Butterfield's distinction between what she describes as the 'state' and 'continuum' models where the former distinguishes only between mastery and non-mastery (i.e. assessment criteria) and the more complex system which identifies stages or degrees of mastery (i.e. grading criteria). The BTEC/EDEXCEL definitions are reproduced below:

Assessment Criteria:

Statements that identify the important features to be present in the performance and indicative of a satisfactory level of achievement.

Grading Criteria:

Statements that identify the important features to be present in the performance and which also enable the assessor to measure the quality of the performance above the satisfactory level.

(BTEC/EDEXCEL 1998 Page 27)

Having provided the above definitions, they go on to identify the essential characteristics of ***grading criteria***, suggesting seven qualities that the criteria must reflect in order to grade a performance beyond 'pass'. The seven qualities are listed below:

Breadth, going beyond the basic ideas.

Coherence - showing synthesis of concepts from units/modules and skill areas.

Evaluation.

Fluency.

Resourcefulness, creativity/originality, showing consideration for alternatives.

Autonomy, using minimal support.

Adaptability.

(BTEC/EDEXCEL 1998 Page 29)

Here we appear to have a framework for investigating the design of assignments on BTEC (NC) courses at RAF Cosford, and indeed, the essential characteristics of the grading criteria for common skills assessment that is provided by BTEC in their general guidelines for common skills and core themes (May 1992). We must also remember the implications of grading criteria in respect of 'subjectivity'. As Butterfield warned us, the more levels of mastery you introduce, the more judgements have to be made by the assessor, and consequently, subjectivity may become more of a problem.

What Other Assessment Constructs/Characteristics Might be Found in BTEC (NC) Assessment Procedures?

Though I have targeted the areas above as being of added significance within BTEC (NC) assessment, there are many other constructs and characteristics which impact upon BTEC assessment schemes many of which we may compare with our original list of 16 constructs which was provided by Harris & Bell. Again my own experience of teaching on BTEC (NC) courses suggests to me that there is undoubtedly a mixture of both *formal and informal* assessment procedures taking place during the delivery of any academic module. Harris & Bell (1996) suggest that - "informal assessing plays a very important part in education" (1996 page 98), and Rowntree (1996) talks about different levels of formality within classroom assessment suggesting that assessment procedures in general range from - "The very informal, almost casual, to the highly formal, perhaps even ritualistic." (1996 Page 5). During my study a distinction will be made between what is considered informal assessment (i.e. verbal questioning or observation by the lecturer), and what is considered formal (i.e. summative examinations and assignments). There will also be those procedures that

fall somewhere in between, consolidation exercises for example, or formative progress tests that the students may undertake at their discretion.

Related to these ideas is the distinction between *formative and summative* techniques. As we have already noted BTEC/EDEXCEL say little about an overall strategy for assessment though as we have seen, they do offer advice on common skills assessment, assignment design and grading within their 'professional development and training' notes (1998). Even so, to be accredited as a centre for BTEC qualifications, each module to be taught must be approved by BTEC and this requires an application for approval to be submitted which includes an outline assessment strategy. Analysis of documents submitted by RAF Cosford as they moved towards BTEC accreditation during the early 1990's show that only summative techniques were listed during this process and no attention was afforded to formative practices. This suggests that for the purposes of certification BTEC are mainly interested in 'product' and though as we know they attach considerable importance to common skills, they pay little attention to the cognitive 'process' through which that product is achieved. It is apparent that there are many formative techniques in use on BTEC (NC) academic modules, and one only has to look in the handout store at RAF Cosford to see the vast quantity of internally designed diagnostic tests, consolidation questions, revision sheets and post tests to confirm that this is true. So what is to be our criterion for distinguishing between formative and summative procedures for the purpose of this study? A good starting point is the TGAT report of 1988. In considering assessment procedures for the National Curriculum in schools, they seem to treat formative and diagnostic procedures as a single entity, suggesting that there is not a "clear" or "sharp" boundary between the two. (Para.27). This seems to be in line with the definition of formative assessment offered to us by Ecclestone (1996):

"assessment designed to diagnose learning needs, barriers to learning and achievements. This enables teachers to give feedback to learners about the quality of their work and future targets. Formative assessment does not contribute to formal grading or final assessment"

(Ecclestone.K. 1996 Page 173)

In contrast she sees summative assessment as a formal procedure that leads to grading or certification. She defines summative techniques as:

“the formal assessment process that enables assessors and verifiers from awarding bodies to judge evidence of achievement submitted by learners in order to determine a final result or grade in a module or unit, or for a whole qualification.”

(ibid Page 176)

What we have then, are two definitions that should prove helpful in identifying the characteristics/constructs of the scheme that is under investigation. Looking ahead to the second strand of this study, they should also help in establishing a framework for evaluating construct validity when the theoretical basis of the instruments which make up the scheme are juxtaposed with their purpose in the overall strategy.

The remainder of Harris & Bell's constructs seem less ambiguous. *Individual or Group Focus* distinguishes between assessment procedures which are based upon the needs of individual students and which tend to be formative and diagnostic by nature and, assessment procedures for which the overall standard has been determined by a large group and which tend to be summative. Examinations and assignments for example. *Continuous or End Point* also seems quite clear cut. Here we are referring to the difference between procedures that are ongoing throughout a period of study, such as consolidation or progress questions, and examinations, which may test 'product objectives' at the culmination of a module.

Teacher or Learner Judged relates to the difference between assessments that are tutor marked, and those marked by the students themselves. Again we may relate this to the distinction made earlier in this review concerning formative and summative techniques. It is most unlikely that learner judged assessment procedures would be summative by nature though there are instances where the learner's view may be taken into account. (Common skills assessment for instance where self-evaluation forms part of the evidence). It is far more likely that formative exercises will be self-assessed though even here there may be some tutor involvement. Rowntree (1996) suggests that used as a formative procedure, self - assessment has "no barriers", and he goes on to note that regardless of its role in the teaching/learning process, it is also valuable as a "life skill" (Page 144). Even so, he doubts the use of learner judged material as a summative tool, stating:

"The point is, how much notice can be taken of his opinion when it comes to deciding whether he should pass or fail, or get this grade or that, or one label rather than another? Either his assessment agrees with the teacher's, in which case there is no problem, or it does not, in which case there is!"

(Rowntree.D. 1996 Page 146)

For my purposes, to help determine the essential characteristics of the BTEC (NC) assessment strategy, teacher judged procedures will be taken to mean those marked by the tutor for formal purposes, whereas, learner judged exercises will be deemed as those assessed by the learners themselves either for consolidation or for the purpose of revision.

Finally, we must determine which procedures are to be regarded as *internal* and which we are to consider as *external*. Harris & Bell define internal assessment as being that which:

"involves those actually participating in the learning/teaching process having control over the assessment"

(Harris.D. & Bell.C.1996 Page 104)

This definition describes many of the assessment procedures which are currently in use on BTEC (NC) courses at RAF Cosford. Not only do BTEC lecturers design their own formative procedures, but also, subject to BTEC rules and regulations their summative ones, being solely responsible for writing and administering examinations and assignments. External procedures according to Harris & Bell involve an "outsider" (Page 104), somebody brought in for the purpose of assessing. These may include examiners for a public examination or an educational psychologist for example, and one would expect this to be a formal, summative form of assessment leading to some sort of grade or certification. There are in addition those grey areas where an assessment is set and administered internally, but is later verified by an external assessor from an examination board. For my purposes, this type of procedure will form a third category, as it may not be reliably classified under either of the definitions offered above. Though procedures of this type are often set and administered by the people involved with the teaching/learning process, they are normally summative by nature and the accrediting board have the final word on standards. Consequently, these procedures will be classified as 'Internally Set - Externally Verified' for the purposes of this report. This section of the literature review is concluded with a summary of the

definitions that have been derived from my reading so far and which will form the basis of the first strand of my research later in this report:

Summary of Definitions:

INFORMAL:	Verbal questioning, Observation and the like. Assessment which takes place as a by-product of normal classroom teaching, and for which no records are kept.
SEMI-FORMAL:	Consolidation or Revision Papers etc. Carried out at the students discretion, though there may be some tutor involvement. Not of a summative nature.
FORMAL:	Summative Examinations and Assignments. Carried out for the purpose of grading or certification.
FORMATIVE:	Assessment designed to diagnose learning needs and to aid the process of teaching and learning. Formative assessment does not contribute to formal grading or certification.
SUMMATIVE:	The formal assessment that enables assessors and verifiers from awarding bodies to judge evidence of achievement submitted by learners. The results from summative assessment are used to determine a final grade in a module or unit, or for a whole qualification.
PROCESS:	The assessment of process necessitates a focus on student activities and the assessment of transferable skills which are common to a number of subject disciplines.
PRODUCT:	The assessment of a training or product objective. This type of assessment is normally summative by nature, and tests whether the learner has achieved what they set out to achieve.
CRITERION REFERENCED:	Assessment based upon statements that describe how to assess learning outcomes to the required standard and quality of performance.
NORM - REFERENCED:	Assessment which aims to compare the achievements of the learner with those of other learners.
INDIVIDUAL FOCUS:	Assessment procedures which are based upon the needs of individual students. Formative and Diagnostic by nature.

GROUP FOCUS:	Assessment procedures for which the overall standard has been determined by a large group. Tending to be summative by nature. (e.g. Public examinations etc.).
CONTINUOUS:	Assessment procedures which are ongoing throughout a period of study.
END POINT:	Assessment procedures which take place at the end of a period of study such as end of phase examinations etc.
LEARNER JUDGED:	Formative procedures by which the learner assesses their own progress. Self-assessment.
TEACHER JUDGED:	Those assessment procedures which are marked by the tutor. May be formative or summative by nature.
INTERNAL:	Assessment procedures which are designed and administered by those having control over the teaching/learning process.
INTERNALLY SET EXTERNALLY VERIFIED:	Those procedures which are designed and administered by those who control the teaching/learning process, but, are then verified by an 'outsider'. Summative by nature.
EXTERNAL:	Assessment procedures which are designed and administered by an outside body. Often involving an 'outsider' being brought in to carry out an assessment.

Part 2: The Validity of the BTEC (NC) Assessment Scheme in terms of 'Construct' and 'Content'.

To consider the validity of an assessment scheme, it is necessary to recognise that validity itself takes many forms. The authors of the E819 study guide (O.U. 1990), refer to construct, content, and functional forms of validity (pages 91/92), and further analysis of recent literature reveals reference to predictive validity (Futcher 1987 page 261), educational validity (TGAT 1987 para. 48) and ecological validity (Gardner 1992 page 101). For the purposes of this study, I shall be initially concerned with 'construct' and 'content' forms of validity as these issues are fundamental to assessment practice and to some degree underpin the appropriateness of an assessment scheme. A more searching investigation into the wider aspects of validity will be introduced as this study progresses.

The concept of validity appears to have evolved as an issue in educational assessment during the 1970's, though it should be recognised, that many of the issues surrounding validity had been identified as long ago as 1926, when the Hadow Report acknowledged some of the inadequacies of assessment procedures at that time, and suggested a number of ways in which improvements could be made. (Quoted within Morrish 1970 page 55). In recent times, validity has become one of the primary considerations in evaluating whether an assessment scheme is appropriate for a particular purpose, and indeed, what its limitations are in achieving that purpose. It is for this reason that validity and related matters will be key issues within this review and in the study that follows.

Construct Validity - How do we Define it and How may it be Evaluated?

Futcher (1987), defines 'construct' validity as being concerned with the "theoretical basis of the test" (page 261), and he goes on to state that :

"If a test is based upon inaccurate analysis of the task to be measured then the test will not be a valid measure of that task."
(Futcher 1987 Page 261)

This definition appears to be in line with other literature on the topic. Reece & Walker, describe the construct validity of an assessment as - "the extent to which it is appropriate to the course, subject or vocational area concerned" (1995 page 361), and go on to note that - "If methods of assessment are chosen purely because they are easy to administer or because they are easy to mark, the construct validity of the assessment may be questioned." They extend their work to include a number of techniques through which construct validity may be improved. The ideas that they propose will be examined, and to some degree utilised, in a later stage of this report.

Within the government white paper 'Better Schools' (1985), the authors devote an entire chapter to "Testing and Fitness for Purpose" (pages 50 - 58). Here, they explore many issues which are pertinent to 'construct validity', and suggest that 'fitness for purpose', as a minimum condition, must satisfy certain basic criteria. These criteria are reproduced below:

- "i)** The particular purpose for which testing is undertaken must be unambiguous and matched to appropriate procedures.
- ii)** Testing procedures should be used which minimise potentially damaging side effects; and,
- iii)** They must be consistent with the aims and objectives embodied in the curriculum and the teaching strategies employed."

(Department of Education & Science. 1985. Page 51)

Analysis of these criteria show that they not only relate to construct validity, but they also bring out the close interrelationship between construct and content, Consider point (i), here we are clearly concerned with the basic construct of the test and its relationship with 'purpose'. As Denvir reminded us:

"The forms of assessment are many and what is chosen and implemented affects fundamentally the learning experiences of the pupils. The choice will be determined by the particular purposes which it is intended to fulfil. In turn both the purposes which are chosen and the methods which are used to achieve the required ends reflect assumptions about the purpose of education and the nature of learning"

(Denvir.B. 1989 Page 277)

Though Denvir fails to mention validity by name, what she says here clearly impacts upon the validity of any assessment procedure that is chosen incorrectly and fails to fulfil its purpose. Let's take an extreme example. If the purpose of an assessment is to ascertain whether a student can mend a puncture in an aircraft tyre, it is very unlikely that an extended essay would be chosen as the means of assessment as it would lack construct validity. It is far more likely that the instructor would wish to observe the student actually carrying out the task, as this is a vehicle that is seemingly well suited to the purpose of the assessment and would, as a consequence, enjoy good construct validity. The implications of such a choice seem obvious, but all too frequently are neglected, often for reasons of convenience. The result is a reduction in construct validity to unacceptable levels.

Point (ii) raises further important issues and in particular some traditional anxieties about the undesirable side effects of some assessment procedures, which can result from a poor choice regarding assessment construct. One obvious example is the side effects of examinations, great if you're top, but, reinforcing failure for those at the bottom. Also, with formative procedures, testing can be self-fulfilling in respect of how tutors view their students, and perhaps more seriously, how students view themselves. In addition, it can actually influence the design of curricula by reducing them to easily tested objectives. There is also the possibility that certain types of assessment instrument advantage some learners while disadvantaging others, an issue that will be explored in strand 4 of this report.

Finally, we must consider the points embodied within point (iii). Here the authors bring construct and content validity together by stressing that assessment procedures must be consistent with the aims and objectives inherent within the curriculum, and by alerting us once more to the close relationship between assessment and the teaching strategies which support the process of learning. These are issues that will be explored later in this study when the underpinning principles at RAF Cosford are evaluated, and correlation between those identified and the assessment instruments that support them investigated.

Benett (1993) examines 'construct validity' in the context of work-based learning where the emphasis is on the assessment of competence. He explores the relationship

between the learning of theoretical concepts in a college and the assessment of learning in the workplace stating that:

“Evidence of convergence between these assessments would support the claim of construct validity for the former.”

(Benett 1993 page 281)

He goes on to discuss issues relating to the assessors intentions and concludes that:

“these formulations would take us back to the fundamental point that an essential component of the validity of assessments is the assessor’s intention.”

(ibid page 281)

This returns us to the points raised by Denvir (1989) as it has links with assessment purpose. As Benett (1993) goes on to note, assessors should be very clear in identifying the “boundaries and limitations” (page 281) of any interpretations made on the basis of an assessment.

Dawson & Thomas (1972), take a different angle on 'construct validity' and suggest ways in which it may be appraised. They stress that construct validity is concerned with - "the psychological qualities measured by the test", and they go on to suggest that - "It is evaluated by demonstrating that certain explanatory constructs account to some degree for performance on the test" (Page 25). One evaluation technique that they bring to our attention is based upon factor analysis. They state:

"The use of factor analysis is one method which helps to establish construct validity. It is a statistical tool for analysing a large number of variables in order to see if there are few or indeed any identifiable dimensions which can be used to describe many of the variables being tested."

(Dawson.J.B. & Thomas.G.H. 1972 Page 25)

Reading further, I think what they are suggesting here, is that new tests which have been designed to test a specific skill, must be seen to correlate with existing tests that themselves intercorrelate to test that skill. If that is the case then the new test is said to have construct validity.

Reece and Walker (1995), offer what I consider to be a more appropriate starting point for evaluating 'construct validity', suggesting that assessment methods should be cross referenced with learning domains, which they further suggest, may be identified by establishing which objectives belong to each domain. Their idea seems to be based upon the work of Bloom (1956) who first identified learning domains and went on to talk about levels or taxonomies within the domains that he identified. The framework which Reece and Walker provide (1995 Page 362) is included as table 2.1 below as a suggested starting point for my own evaluation of construct validity that is documented later in this report.

Objectives	Possible Assessment Methods
Lower level cognitive	Multiple choice questions. Matching block questions. Short answer/completion questions.
High level cognitive	Structured/extended essay. Assignment or project.
Psychomotor	Skill test observation. Assessment of skills at work. Self assessment related to a checklist. Assignment or project.
Affective	Tutorial or discussion. Peer assessment. Observation.
Personal effectiveness	Self assessment. Discussion or tutorial. Peer assessment.

Possible Assessment Methods to Improve Construct Validity.
(Reece.I. & Walker.S. 1995 Page 362)

Table 2.1.

It should be noted that the development of Reece and Walker's work which is offered above is not suggested as a watertight method for evaluating construct validity, simply a starting point. As Reece and Walker warn us:

"What is right for one course might be different for other subjects or for different vocational areas. In consequence, only a range of possible methods can be given for the different types of objective."
(Reece.I. & Walker.S.1995 Page 362)

To summarise, there seems to be some agreement that 'construct validity' relates to the theoretical basis of the assessment procedure and its suitability for the purpose it is being used. Evaluation techniques vary from the statistical methods described by

Dawson & Thomas, to the more qualitative approach based upon the ideas of Reece & Walker. In essence, it is a concept that implicates a multitude of variables and as a consequence, a full evaluation will only evolve as the study progresses and more of the factors that require consideration are investigated.

Content Validity: Definition and Techniques for Evaluation.

Evaluating the 'content validity' of the BTEC (NC) assessment scheme at RAF Cosford represents a significant part of this study. This will involve a mapping and statistical exercise supported by qualitative analysis where necessary. On the face of it, content validity seems to be quite a simple concept that asks the question - does the content of the assessment scheme adequately sample the content of the learning situation? At RAF Cosford where the learning situation is entirely based upon objectives, to assess content validity at a basic level will require work on two fronts - firstly, do the objectives in the syllabus map to the assessment topics, and; secondly, are the weightings correct between time allocated to particular objectives in the syllabus, and marks allocated to those same objectives during assessment?

Reece and Walker, suggest ways of improving content validity during the design of assessment procedures by drawing up what they describe as an "assessment specification." This they suggest, is a technique which attempts to ensure that you sample:

- "a) The content of the course/topics; and,
- b) The different abilities tested."

(Reece.I. & Walker.S. 1995. Page 363)

They go on to note that:

"it is probably impossible that you will be able to cover all of the objectives or competencies and all of the content in the time available for testing. Thus, you have to sample both content and abilities. You must ensure that this sampling is representative of both the content and the abilities in order that you increase the validity of the assessment."

(ibid. Page 363/364)

It would seem apparent, that if an assessment specification of this type can be used to help in the design of an assessment instrument, it necessarily follows that it may also

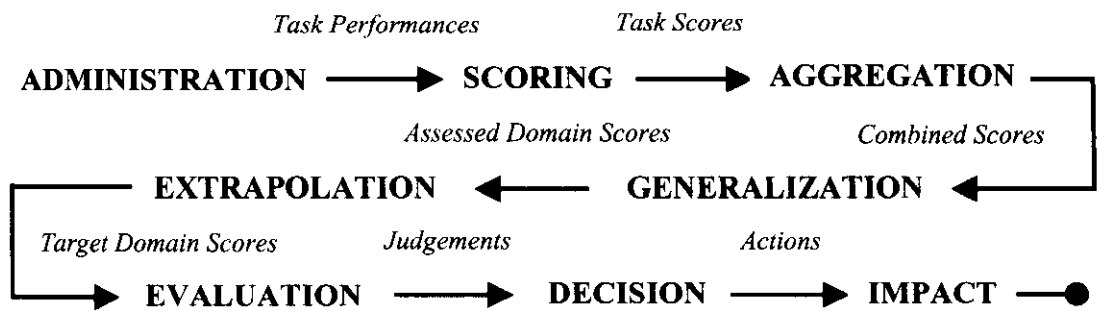
Unitary Validity.

The concept of ‘unitary validity’ is embedded in the work of the American Educational Research Association (AERA) and forms the basis of the American standards of test construction. Messick (1989) goes some way to defining the unified view of validity. He states:

“Validity is an integrated evaluative judgement of the degree to which empirical evidence and theoretical rationales support the adequacy and appropriateness of inferences and actions based on test scores or other modes of assessment.”

(Messick.S. 1989 page 13)

Crooks et al (1996), suggest that interpretations of performances on assessments necessarily involve a series of linked inferences and assumptions. They go on to suggest an approach to validation in which assessment is described as being divided into eight conceptually distinct stages with validation then based on careful scrutiny of each. They compare the eight stages to eight links of a chain stressing that weakness in any one link will weaken the chain as a whole (page 266). Guidance is offered to the assessment validator through identification of possible “threats to validity” (page 266), though the list of threats presented is intended to be illustrative rather than comprehensive. The model provided by Crooks et al (1996) is shown below:



(Adapted from Crooks et al 1996 page 268)

The model shows the eight distinct stages defined by Crooks et al (1996) who emphasise the importance of moving systematically through each stage of the validation process beginning with the administration link. The prompts which are shown in italics help the validator to move through the process. For example, towards

the end of the process evaluation leads to judgements, which in turn lead to decisions on actions, resulting in the ultimate impact of the assessment being considered.

Moskal & Leydens (2000) are similarly concerned with the valid interpretation of assessment results and present their own approach in the context of scoring rubrics. They suggest that validation is the process of accumulating evidence that supports the appropriateness of the inferences that are made of student responses for specified assessment uses (page 1). This suggestion is largely in line with the views of La Marca (2000) who is concerned with the alignment of standards and assessments as an accountability criterion. La Marca seems to be of the same mind as Messick (1989) who argues that validity is not a quality of a test, but concerns the inferences drawn from test scores or performance. Both agree that “validity is not a static quality, it is an evolving property” (2000 Page 3), and La Marca goes on to stress that he sees validation as an ongoing process, not a practice that ends when the design stage is accomplished. This takes us back to the work of Crooks et al (1996), who write about the validation of an “assessment process” (page 280), rather than the validation of an assessment instrument. Their chain model acknowledges that the consequences of an assessment are an integral part of the validity of the assessment process. They also recognise the importance of administering assessment, using the computer analogy of “garbage in leads to garbage out” (ibid page 280) to explain their point.

To conclude this section of the literature review, the validation model offered by Crooks et al (1996) seems to capture the main principles of ‘unitary validity’ that are embedded in the work of AERA (1985). The model shifts the emphasis from traditional conceptions of assessment instrument validation to one based on inferences, assumptions and actions. Validation is based on the whole assessment process thus unifying what advocates see as eight definable stages from administration through to impact. Though this study will be focused largely on construct and content, the unitary view clearly has implications for fairness and impartiality and should not be overlooked.

Part 3: Learning Theory and Approaches to Instruction on the BTEC (NC) Academic Units?

The BTEC/EDEXCEL academic units are largely founded upon the traditional principles of behaviourism. They are underpinned by what BTEC describe as ‘outcome objectives’, each of which is broken down into more specific objectives, or as BTEC define it, ‘indicative content’. An extract from the BTEC unit – Mathematics (14576F) is included below to help illustrate these definitions. Further comment is also provided on page 35 of this report:

Section	Outcome Objectives and Indicative Content. On completing this module learners will be able to:
A. Formulae and Laws.	<ol style="list-style-type: none"> 1. Use an orderly approach to the evaluation of formulae and expressions, with and without the use of a calculator. <ul style="list-style-type: none"> • Exponential equations of the form ax^n • Tables of values from a formula for different values of a variable. • Transposition to change the subject of a formula, including exponential formulae and formulae in which the subject is contained in more than one form. • Effects of errors and rounding.

Extract from BTEC National Programmes: Engineering: Study Area Aerospace Studies: Guidelines and Module Specifications 07-120-3 Issue 1 March 1993.

Over the past 10 years or so, there has been a shift in the BTEC/EDEXCEL philosophy, which currently advocates a more active approach on the part of the student, and a more diverse role for the lecturer (see BTEC 1998). Consequently, we now have a mixture of behavioural and process based approaches interspersed on each of the academic units with academic elements ‘delivered’ to students in the classroom, and an experiential active role for the learner during work in the laboratory.

The instructional techniques used to accommodate the behavioural and process approaches to learning are themselves diverse and depend largely upon the lecturer. It is BTEC’s hope that the interspersion of different approaches will accommodate all students’ instructional preferences during the delivery of a BTEC unit. As Curry (1983) informs us, implicated here is the student’s cognitive style and their individual

learning style. In this research I am interested in the instructional approaches that are evident at RAF Cosford and the cognitive and individual learning styles of the students. Once this investigation is complete, I may then begin to evaluate whether the range of assessment instruments identified in strand 1 are appropriate for this programme. I begin with a brief review of instructional approaches on the pages that follow.

BTEC/EDEXCEL (1998), advocate as one of their underlying principles 'learning through experience', a philosophy which appears to be based upon the work of D A Kolb (1984), who first proposed what has become known as the "Experiential Learning Cycle." Kolb claims that the fundamental elements of such a cycle bring together the theoretical and practical aspects of learning and shift the emphasis to the application of what is known and understood. Kolb's experiential learning cycle is reproduced below:

The Experiential Learning Cycle:

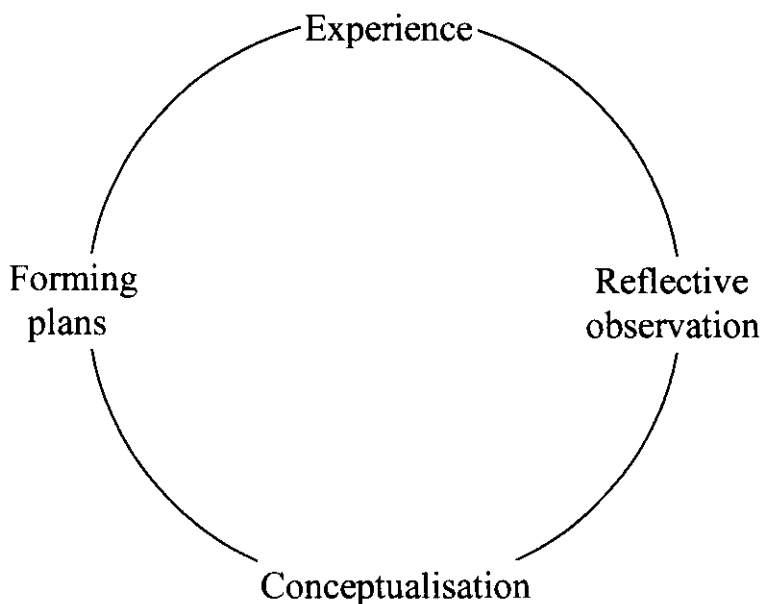


Figure 2.1

*Adapted from D.A.Kolb
Experiential Learning 1984*

As early as 1979, Kolb, Irwin and McIntyre were writing about the relationship between learning and problem solving, which ultimately led to Kolb's experiential learning cycle. In fact, it is within this work that reference to the cyclical model that he

created was first evolved. A major concern at that time appears to have been the assumption that many people considered the two concepts to be separate and distinct from one another with learning restricted to the classroom and problem solving a form of life skill which was necessary within our daily lives and work. They suggested that:

"By combining these characteristics of learning and problem solving and conceiving of them as a single process, we can come closer to understanding how it is that people generate from their experience concepts, rules, and principles to guide their behavior (sic) in new situations, and how they modify these concepts in order to improve their effectiveness. This process is both active and passive, concrete and abstract. It can be conceived of as a four stage cycle: (1) concrete experience is followed by (2) observation and reflection, which leads to (3) the formation of abstract concepts and generalizations, which lead to (4) hypotheses to be tested in future action, which in turn leads to new experiences."

(Kolb, Irwin & McIntyre 1979. Page 37)

They go on to alert us to a number of points relating to the cycle:

"First, this learning cycle is continuously recurring. We continuously test our concepts in experience and modify them as a result of our observation of the experience. In a very important sense, all learning is relearning and all education is re-education"

(ibid Page 37/38)

So what is this relationship between learning and problem solving and are the two concepts compatible as BTEC imply? Schlesinger (1996) suggests that learning is not a cycle at all questioning the behavioural ethos of the model. There will be more reference to his work later in this review. André (1986) suggests that the theory of 'problem solving' is as yet underdeveloped (1986 page 60), and though work in this area has become more fashionable over the past 20 years or so, I remain doubtful whether a complete theory has yet been evolved. Even so, enough work has been completed for us to make certain assumptions about this concept and to look in sufficient detail at its relationship with different theories of learning. André defines problem solving as consisting of:

"The mental and behavioural activities that are involved in dealing with problems."

(André 1986 Page 61)

He goes on to examine three approaches to problem solving including "The behavioural approach" and the "Cognitive information-processing model." (Pages 62 - 65). Both of these models are of relevance to this study. The basic behavioural model of problem solving is associated with the work of Thorndike (1898), and has been developed by a number of theorists including Skinner (1966) and Mayer (1983). At the centre of this theory is the idea that trial and error learning occurs when a stimulus situation demands a response, however, as André points out:

"The correct response is not dominant in the response hierarchy for that situation"

(ibid Page 62)

He goes on to suggest that a learner will try out responses in their order of dominance and eventually incorrect responses are extinguished, and the correct response reinforced until it becomes dominant in that situation. This simplistic interpretation appears to leave little scope for thought and planning in the solving of problems, though as Davis (1973) argues, it is clear that in most situations humans do think about problems before engaging in behaviour. This leads us to a more developed view of behavioural psychology of the type described by Cegelka and Lewis (1983). They develop a behavioural strategy for teaching about the 'slope of a line', suggesting that their broader approach falls under the heading "Applied Behavioural Analysis" (1983 Page 171). Here we have moved away from Thorndike's simplistic view of behaviourism to a complex procedure that moves students through a - "series of progressive approximations to the target behaviour" (1983 Page 173), a concept which appears to be similar to the approach at RAF Cosford, and which, as a consequence, requires further analysis.

Applied Behavioural Analysis & its Relationship with BTEC (NC) Courses at RAF Cosford.

Cegelka and Lewis (1983) identify the primary features of applied behavioural analysis as being:

1. Statement of the desired behaviour in clearly observable terms.
2. Identification of available reinforcers for shaping the behaviour.

3. Specifying the contingent relationship between the target behaviours and the reinforcers.

4. Developing the instructional programme.

(1983 Page 171)

They go on to design an instructional programme based upon the above for the teaching of 'slope'. For this purpose they propose what they describe as an "autoinstructional approach" (1983 Page 173), through which each student proceeds at their own pace providing written responses to problems which may be immediately compared to the correct responses provided and thus, either confirmed or corrected. For this type of programme to succeed they suggest that two major types of behaviour must be specified - i) the entry level skills of the students, and, ii) the desired terminal behaviours. For the purposes of the example given (i.e. the teaching of slope), they go on to identify 3 entry-level skills and 3 target or terminal behaviours. These are reproduced below:

Entry Skills: It is assumed that students are able to:

1. Perform simple arithmetic calculations with whole numbers, fractions and negative numbers.
2. Define trigonometric terms such as tangent and angle of inclination.
3. Plot points on a grid and, given a point, identify its coordinates.

Target/Terminal Behaviours:

1. Given the co-ordinates of any two points of a straight line, the student will calculate slope.
2. Given grids with units of varying sizes, the student will identify lines of the same slope.
3. The student will demonstrate whether the slope of 'z' with respect to 'y' is equal to the slope of 'y' with respect to 'z'.

(Cegelka & Lewis 1983 Page 174)

They progress to analyse in detail the first of the terminal behaviours, - 'the calculation of slope', which is initially broken down into six sub-skills. These are reproduced below:

Sub-Skills:

1. Given co-ordinates of two points, plot line.
2. Given a line and two points, identify co-ordinates of the points.
3. Demonstrate that slope of a line is equal to the tangent of the angle of inclination.
4. Given a line and two points, describe procedure for calculation of tangent and the angle of inclination.
5. Given a line and two points, calculate slope using the formula

$$\text{Slope} = \frac{y_2 - y_1}{x_2 - x_1}$$

6. Given a line and two points, calculate slope.
(ibid 1983 page 174)

They go on to suggest that each sub-skill would then require a sub-programme, each of which would include:

1. Presentation of task.
2. Opportunity for practice.
3. Assessment of mastery.

Individualisation may be built into the programme they suggest, by varying the amount of practice according to the students rate of correct responses or, alternatively, by allowing students to branch off to sub-programmes if they are deficient in entry skills or, if the number of incorrect responses suggests weakness in a particular area.

So how does this approach to teaching and learning impact on BTEC (NC) courses at RAF Cosford? Without wishing to pre-empt the findings of my research, it seems apparent that there is some correlation. A brief review of an instructional specification (I.S.) for any module, reveals that two types of objective are in evidence, firstly, what are called 'training objectives' (TOs), and; secondly, what are described as 'enabling objectives' (EOs). These are largely derived from the BTEC module specifications

which identify 'outcome objectives' and 'indicative content' and which were illustrated on page 29 of this report. At first glance, TOs and EOs seem very similar to what Cegelka & Lewis describe as 'target behaviours' and 'sub-skills'. Furthermore, the first objective to appear in the I.S. requires the student to sit a diagnostic test. Again, we may liken this to the first stage in Cegelka & Lewis's approach, where the entry level of students must be ascertained in order for the programme to progress. It would appear that there is some similarity between the two approaches and certainly, considerable scope for investigation during this study.

Information Processing - A Viable Alternative?

There are of course other approaches to teaching 'slope' which may prove perfectly adequate. In the same paper Jill Larkin develops an approach based upon the information processing philosophy that became fashionable in the early 1970's. Such models appear to lend themselves to an algorithmic approach to curriculum design but may still begin with an objective, or a solution aimed at, in response to a problem.

Danner, who analyses the information processing approach within the same paper suggests that it is a model "which emphasises both the task and the learner in a way which is different from either behavioural or Piagetian approaches", and he goes on to note: "That the key to solving an instructional problem is understanding how it is represented by the learner." (1983 Page 184)

Wood (1988) also considers the information processing approach and suggests that it is an approach that represents a "major shift in orientation" (1988 page 12) if considered as an alternative to traditional behavioural models. He refers to the specific terminology associated with the information processing approach and suggests that words such as 'goal', 'means' and 'control':

"change the description of human activity from one couched in terms of responses to stimuli to accounts which talk about more-or-less skilled actions aimed at goals"

(1988 page 12)

He goes on to note that it was the theory of information processing that led to the development of concepts such as 'plans', 'skills' and 'strategies', and to a particular way of thinking about "expertise" (ibid page 12), he states:

"I use the term expertise to draw attention to the fact that knowledge and action, or concepts and procedures, are two aspects of a single process."

(ibid page 13)

From this perspective 'expertise' seems to form the basis of Woods' view of information processing. Different levels of expertise and how he views the difference between the adult and the child or, the expert and the novice suggest similarities between this theory of learning and 'social constructivism'. It is to this theory of educational instruction that I now turn my attention.

Constructivist and Social Constructivist Instruction.

In addition to the behavioural and information processing models, we must also consider Piagetian and Vygotskian approaches which come under the umbrella of 'constructivism' and 'social constructivism' respectively. Wood (1988) examined constructivist theories of learning and concluded that Piagetian constructivism and Vygotskian social constructivism have a number of common features. One particular similarity that he identifies is the emphasis on 'action'. Both schools of thought see activity as the basis for learning and the development of thinking. Where they differ is in their emphasis on language and social interaction. Vygotsky saw language and social experiences as playing a far more important role in learning and mental development than Piaget, and instructional techniques that support Vygotsky's ideas reflect this difference in opinion.

Although both Vygotsky and Piaget were interested in the development of the child, their contribution to pedagogical theory has quite rightly been carried forward to the adult world and now has a significant influence upon andragogical² techniques. Britton (1987) investigated a Vygotskian approach to instruction suggesting that if we accept social constructivism then:

² Andragogy is to adult education what pedagogy is to the education of children. It is a term used and explained by Reece & Walker (1995). (See also, <http://www.learnativity.com/andragogy.html>)

“We must revise the traditional view of the teacher’s role.”

(Britton 1987 page 213)

Roth (1999) went further in analysing the Vygotskian approach stating that:

“In Vygotsky’s theory, robust understanding and knowledge are socially constructed through collaborative talk and interaction in and around meaningful, whole activities.”

(Roth 1999 page 11.)

He went on to note that:

“novices develop cognitive skills, that is they become fully fledged members, by participating in joint activities with more knowledgeable others.”

(ibid page 11)

At the centre of Vygotsky’s approach to instruction is what he describes as the ‘zone of proximal development’ (ZPD) (see Vygotsky (1978), Britton (1987), Wood (1988) and Roth (1999)). Although this concept is normally associated with the notion of the developing child, it seems sensible to suggest that accessing the students ZPD is also a technique now associated with the education of adults (see Wood (1988) page 24). In the context of BTEC (NC) courses at RAF Cosford there is undoubtedly scope for Vygotskian techniques within the behavioural framework that surrounds each module. This would involve opening up each learners ZPD and encouraging interaction in such a way that each student reaches their ‘assisted performance’ level rather than their ‘unassisted level’. Evidence of such approaches to instruction will be sought during classroom observation and the findings reported later in this study.

Theories of Learning & Instructional Preferences at RAF Cosford.

So which approaches to learning and instruction may we identify as underpinning the BTEC (NC) academic modules at RAF Cosford, or do we have a combination of underpinning philosophies impacting at different stages of instruction? Indeed does the underpinning theory of learning that we may identify through the syllabi and training manuals reflect the type of instruction that lecturers are delivering in the classroom?

We have already suggested that there is some correlation between Cegelka & Lewis's 'applied behavioural analysis' and the approach which is evident within the BTEC instructional specifications at RAF Cosford but, this does not necessarily mean that behavioural approaches to instruction will be evident in the classroom. Looking beyond the training documentation, to the wider aspects of the course, we also have the practical and laboratory assignments that form a significant part of both the teaching and the assessment of students. Not only do assignment marks contribute to the summative grading of students, but also, many common skills are assessed through this approach. As we have seen BTEC/EDEXCEL (1998) advocate the principles of 'experiential learning' for assignment design, thus, necessitating a specific approach by teaching staff. Whether the experiential approach to learning is being adopted is a question that will require a detailed documentary analysis of laboratory and practical assignments. This will ascertain whether the BTEC guidelines for assignment design (BTEC 1998) are being applied in practice. There is, therefore, much work to be done in this area of research, if we are to achieve a wider understanding of the appropriateness of our assessment on the related aspects of student cognition and individual learning style. This review continues with a brief investigation into these important issues.

Part 4: The Relationship between Assessment Performance and Individual Learning Styles during BTEC (NC) Assessment.

Cognitive Style or Learning Style?

The instructional styles examined above may not be considered in isolation. The instructional preference of a particular lecturer, or the instructional style demanded by a particular situation is just one of the factors that influence any learning experience for the student. Curry (1983), suggests that the success of a learning experience depends largely upon the individual style of the learner, and he goes on to propose that this may consist of three factors which we may consider as layers of an onion. Cited in Rayner and Riding (1997) he states:

“The inner core of the ‘style onion’ is made up of personality-centred models, leading to a second strata of information-processing models, and then to an outer layer of instructional-preference models.”

(Rayner & Riding 1997 Page 22)

Sadler-Smith (1997) goes one step further, suggesting that if we are to view individual learning styles in a holistic way, then we must consider four aspects of individual difference. He identifies these as - learning preferences, learning styles, approaches to studying and cognitive style (Page 52). If we compare his ideas to Curry's 'style onion', there are a number of similarities. Firstly, he states that learning preference may be defined as "an individuals propensity to choose or express a liking for a particular instructional technique or combination of techniques" (Page 52). This reflects the outer strata of the style onion. Secondly he describes 'learning style' in terms of Kolb's model of 'experiential learning' (1984). This would fit into the second strata of the style onion relating to information processing models. In addition, however, Sadler-Smith refers to approaches to studying and cognitive style. The former seems clear enough, he defines this as: "how students tackle reading academic articles and texts" (Page 53) but, his definition of 'cognitive style' leads to some ambiguity. If, as he states cognitive style is: "the distinctive and habitual manner of organising and processing information" (Page 54), then there appears to be some overlap with 'learning style' and a clearer definition of each is required before we proceed.

Messick (1976) provides some guidance in drawing a distinction between 'style' and 'strategy'. He appears to be suggesting that an individual's cognitive style exists at a higher level than strategies for problem solving or learning, perhaps indicating that cognitive style is more deep rooted and difficult to change than some of the lower level operations such as problem solving. We may gain a further insight into the differences between cognitive style and learning style by considering the instruments that purport to 'measure' the two dimensions. Sadler-Smith (1997) refers to the work of Riding and Cheema (1991) who identify two cognitive style "families", suggesting that learners may differ in terms of two basic characteristics (Page 55). These they define as the "wholist-analytical" dimension, and the "verbaliser-imager" dimension. In simple terms, the wholist-analytical style describes the manner in which an individual processes information. Analytics tend to process it into component parts, while wholists prefer to keep a global view of a topic. The verbaliser-imager

dimension describes how an individual represents information. Verbalisers, they suggest, represent information in words, while imagers tend to use a pictorial form.

Riding (1991) has produced an instrument for assessing an individual's cognitive style that he calls the cognitive styles analysis. This indicates an individual's position on the two bi-polar dimensions and places them into one of nine cognitive style categories. An individual may then be described as a wholist-imager, for example, or an analytic verbaliser.

If we accept this perception of cognitive style we may begin to accept that these learner characteristics will be very difficult to manipulate, and the implications for assessment seem quite profound. Certainly, the range of assessment instruments that make up an assessment scheme should accommodate all nine cognitive style categories if we are to give our learners an equal chance of success. To use Curry's terminology, the wholist-analytic, verbaliser-visualiser dimensions would be deeply set somewhere near the core of the 'style onion'. If we begin to move outwards into the second strata, it is here, I believe, we would find the individuals 'learning style', and to understand it more fully we should turn our minds back to Kolb's theory of learning (1984) which is based upon the experiential learning cycle.

The work of Kolb (1984), and Honey and Mumford (1986), represent two widely used approaches to identifying individual learning styles in students and both models take as their basis Kolb's theory of experiential learning. A look back at Kolb's cycle, reminds us that he defined learning as a four-stage action that embodied concrete experience, observation and reflection, formation of abstract concepts and generalisations, and the testing of these concepts in new situations. This he suggested leads to further concrete experiences and as a consequence a further cycle of actions. He went on to describe the 'ideal' learner as somebody with the ability to operate with equal facility at all four stages, but he concedes that such a learner is rare and most individuals have a preference for one or more stages in the cycle.

To assess individual orientations towards learning, Kolb created the 'Learning Style Inventory' (LSI). The final form of this test is a 'nine item' self-description

questionnaire within which each of the nine items asks the respondent to place four words in rank order in a way that best describes his or her learning style. In each four-word item, one of the words corresponds to one of the four learning modes identified above. For example, if we consider item three, the learner is asked to place the words - feeling, watching, thinking and doing into a rank order which best describes their own personal learning style. In this case feeling corresponds to 'concrete experience', watching to 'reflective observation', thinking to 'abstract conceptualisation' and doing to 'active experimentation'. A copy of the nine-item test is included as appendix (B) at the rear of this report.

There have, of course, been a number of studies regarding the validity and reliability of Kolb's LSI. (See Talbot.R. (1985), Sims.R., Veres.J., Watson.P. & Buckner.K. (1986) and Wilson.D. (1986)). A later work by Willcoxson.L. & Prosser.M. (1996) also looks at issues concerning validity and reliability. They refer to LSI1 and LSI2, which are two versions of Kolb's LSI. The first LSI1 was an early version of Kolb's idea that he developed in 1976. This was replaced by a revised version in 1985, which took account of concerns raised about the reliability and validity of the earlier model. (See Geller.L. (1979) and West.R. (1982)). For the purposes of this study I am more interested in the later version LSI2 which Willcoxson.L. & Prosser.M. (1996) evaluated with a group of Australian undergraduates within a university setting. Following a study with a sample of 191 students, they concluded that LSI2 has a "high degree of reliability" (page 253). This conclusion was based upon coefficient alpha reliabilities and scale intercorrelations which the authors claim are consistent with the findings of Sims *et al* (1976) and Veres *et al* (1987) who also found "high internal consistency in LSI2" (page 255).

On the issue of validity, Willcoxson & Prosser (1996) confirm that their findings are inconclusive, though they do suggest that "there is evidence of validity in results which demonstrate different discipline-based learning preferences parallel to those found for LSI1" (page 256). They quote further evidence of validity that is apparent from a factor analysis of the LSI2 scales. In this case, however, the evidence is not so clear cut with differences in the predicted arrangement of factors between subject disciplines. For example, in the science sub sample concrete experience and abstract conceptualisation form a bipolar dimension, and active experimentation and reflective

observation form a bipolar dimension as expected, but, in the arts sub sample (i.e. history, English, sociology, anthropology, linguistics, foreign languages and politics), active experimentation appears to form bipolar dimensions with each of the other three scales. Willcoxson and Prosser suggest that this may reflect differing bases of concept formation in the arts to those in the sciences, though they admit that the evidence from their study is inconclusive and further research is necessary if this hypothesis is to be proved.

Following criticism of Kolb's LSI and fears concerning validity, a new approach to the identification of individual learning styles was developed by Honey and Mumford (1986). They acknowledge Kolb's model as the basis from which they developed a new approach which replaced Kolb's nine item test with an 80 item questionnaire (1986 page 4), and they went on to design a new scoring system for their 'learning styles questionnaire' (LSQ) which replaced Kolb's descriptions of individual learners. They state:

"Our debt to Kolb remains; we have accepted the idea of a four stage process of learning, and we have developed a view of four main styles of learning which appear to have much in common, at the general level, with Kolb. we have diverged in two major ways however. Firstly, we have built our views of the learning styles, and the questionnaire, around recognisable statements of management behaviour. This in turn has meant that our descriptions of learning styles are both more detailed than, and differ from their Kolb equivalents."

(Honey.P. & Mumford.A. 1986 page 4).

If we examine this claim more closely, it seems clear that Honey & Mumford have accepted Kolb's cyclical experiential theory of learning, but have replaced his descriptions of each type of learner with their own variations, these being activists, reflectors, theorists and pragmatists to replace what Kolb describes as divergers, assimilators, convergers and accomodators. They have also devised a new scoring system to identify each type of learner, and though this presents a simple method for non-mathematicians, in my opinion the simplicity of the model has been achieved at the expense of mathematical validity.

If I may first explain Honey & Mumfords system, I may then justify my above comment. The 80 questions which make up the LSQ are split into four distinct groups of 20 questions, each of which maps to one of the four learning styles which have been

identified above, activist, reflector, theorist or pragmatist. The questions from each of the four groups are mixed up in random fashion on the questionnaire and when a respondent completes the LSQ, they are asked to read each of the questions in turn and to tick the ones that they feel best describe them as an individual. The LSQ is included as appendix (C) at the rear of this report. Once this exercise is complete, the first stage of the scoring procedure takes place. In the first instance this involves counting up all the ticks that relate to each of the four learning styles. The respondent is then given a score out of twenty for each style. Next the scores are transferred to a set of axes, each arm of which corresponds to one of the four learning styles. The horizontal axis represents the 'attitudinal dimension', while the vertical axis represents the 'action dimension'. The completed graphic shows individual preferences towards a particular style, thus enabling us to label each learner as having a preference for one or more of the four learning styles. An example is included as appendix (D) at the rear of this report. Next, the four scores are plotted on Honey & Mumfords LSQ profile (see appendix (E)). The LSQ profile is calibrated to take account of the results from a sample of 1302 learners from the general population. These results have been used by Honey & Mumford to produce the general norms for the LSQ and according to the authors: "form a useful basis for comparison" (page 17). The general norm is often shown as a dotted line on the axes described above, enabling an individuals scores to be compared with the norm on each of the bi-polar dimensions.

This in my opinion is where Honey & Mumfords system is weak. Using their model, they tell us that we may now label an individual as a strong activist, for example, with a low preference towards each of the other three styles, or as a moderate reflector with low theorist tendencies. My concern is that we have not really quantified what this means. It is my view that a more accurate analysis of each individual is required if a valid comparison is to be made between learners. My model for achieving this is described in the methodology section later in this report.

Further concern regarding the validity of Honey and Mumford's model is expressed by Schlesinger (1996). He questions whether learning is a cycle at all suggesting that the behavioural flavour of the model "reduces experience to the level of concrete stimulus" (Page 31). Caple and Martin (1994) also raise the issue of experience and ask the question "what is meant precisely by experience in Honey and Mumfords

model?" (Page 17). Allison and Hayes (1988 & 1990) analysed the LSQ as a possible alternative to the LSI and reported evidence of construct validity on the basis that the LSQ was "capable of discriminating between groups which could be expected to differ in their learning behaviour" (1988 Page 276). They also concluded that the LSQ appeared to be "a stable and internally consistent measure of two behavioural or attitudinal dimensions" (1990 Page 866). They did, however, question some aspects of the LSQ's predictive validity on the basis that in their research learners who scored high on the action dimension did not gain the highest project marks. This, they found surprising, as the projects they were undertaking had been designed within the experiential learning ethos. Regardless of the above concerns, they concluded that: "the LSQ may be preferable to the LSI" (1988 Page 278), but they went on to note that:

"until the validity of the LSQ has been satisfactorily established practitioners should remain alert to the possible dangers of putting too much faith in its results"

(Allison & Hayes 1988 page 280)

Cognitive Style & Learning Style: What is their relevance to BTEC (NC) assessment.

To conclude this section of the review, it seems apparent that there is some confusion regarding the exact nature of cognitive style and how it may be distinguished from learning style. For the purposes of this report, cognitive style will be considered as the higher-level heuristics described by Riding & Cheema (1991). They define these in terms of two cognitive style 'families' (wholist-analytical and verbaliser-imager), located in two bi-polar dimensions. I suggested that these aspects of individual style would be at the core of the 'style onion' and difficult to manipulate. Learning style will be considered as the individuals approach to solving problems. This element of individual style may be considered in terms of Kolb's learning cycle and may be measured using either the LSI or Honey & Mumford's LSQ. I would suggest that this aspect of individual behaviour would be in the second stratum of the 'style onion' and thus, would be easier to access and manipulate. It seems sensible to suggest that both the cognitive style and the learning style of the student may have an important influence on how individual students perform on certain types of assessment instrument. Consequently, they are important concepts in evaluating the appropriateness of the RAF Cosford assessment scheme if we are to ensure that

individual students are neither advantaged nor disadvantaged during summative testing. One of the questions I wish to consider is whether the summative aspects of assessment on the BTEC (NC) academic modules are appropriate for each of the four types of learner (activist, reflector, theorist and pragmatist). This will necessitate identifying individual learning styles in a sample of students with a view to establishing whether their learning style has a significant effect on performance during selected BTEC (NC) assessments.

Part 5: Perspectives on Knowledge & its Relationship with Performance during BTEC (NC) Assessment.

Lerman (1983), cited within the Open University E819 study guide, considers knowledge in the context of mathematics suggesting that there are only clear distinctions between two perspectives - "mathematics as a body of knowledge or as a way of thinking" (Page 57). In the education of adults, these alternative views of the nature of mathematics lead to entirely different andragogies and have a profound impact on the nature of assessment. It is relevant to this study as the majority of the BTEC (NC) academic units taught at RAF Cosford are mathematically based.

Consider the first scenario whereby mathematics is taught as a hierarchical body of knowledge. Lerman suggests that this philosophy would result in "purposeless tasks" for students who would be expected to "discover concepts." (E819 S.G. Page 57). To put this another way, he seems to be distinguishing between procedural knowledge and conceptual knowledge, a distinction that appears to have significant implications for the way we teach and assess learners. Hiebert (1986) examines the relationship between conceptual and procedural knowledge forms providing us with some useful definitions. Conceptual knowledge, he states:

"is characterised most clearly as knowledge that is rich in relationships"

(Hiebert 1986 page 3)

He goes on to distinguish between two levels at which relationships may be established, and suggests that these may be identified by the degree of 'abstractness'³ that exists within the relationship. The lower level relationships tend to be context

³ The term abstract is used by Hiebert to refer to "the degree to which the unit of knowledge (or a relationship) is tied to specific contexts." (1986 page 5).

specific, while the higher or reflective level relationships may be generalised to more diverse contexts.

If conceptual knowledge is to be defined as abstract and reflective, then we may define procedural knowledge as ‘action orientated’ - an ability to execute procedures. As in the case of conceptual knowledge, Hiebert suggests that procedural knowledge forms exist on two levels. At one level he states, it involves:

“ a familiarity with the individual symbols of the system with the syntactic conventions for acceptable configurations of symbols”

(ibid page 7)

At a second level, procedural knowledge is described as non-symbolic’ and may be considered in terms of a problem solving strategy. Hiebert suggests that at this level it:

“consists of rules or procedures for solving mathematical problems”

(ibid page 7)

He illustrates the difference between the two types of procedural knowledge by reference to two examples. Consider the mathematical problem $\frac{1}{8} + \frac{3}{4} = \square$. This problem is punctuated by symbols (i.e. $\frac{1}{8}, +, \frac{3}{4}, =$ etc.) and requires level one procedural knowledge to solve it. If we consider a second example, in which a student is asked to use a compass and ruler to construct a hexagon, this would require procedural knowledge at level two. This problem is non-symbolic and requires the application of rules and procedures.

Von Glasersfeld (1987) talks about the construction of ‘viable’ knowledge (Page 12). He seems to agree with Piaget’s theory of constructivism and views knowledge as being operative and reflective. He also goes one step further, however, in suggesting that operative knowledge is not simply the “associative retrieval of a particular answer” (Page 12). Operative knowledge he states:

“is best demonstrated in situations where something new is generated, something that was not already available to the operator.”

(Von Glasersfeld 1987 page 12)

Barnes (1988) further enlightens us about 'types' of knowledge in differentiating between "educational knowledge and knowledge for action" (Page 75). He seems to be distinguishing between decontextualised theoretical knowledge and the type of knowledge that is relevant to everyday living and he appears to acknowledge that 'solving problems' probably leads to a more useful form of knowledge than traditional teacher centred approaches (see page 77).

Hennessy (1993) goes one step further in advocating 'situated cognition'. She suggests that:

"formal teaching lacks relevance to mathematics as commonly practised in everyday life."

(Hennessy 1993 page 5)

She also acknowledges that mathematics is not the only area where such problems exist and refers specifically to science and technology as other problem areas concluding that:

"Evidence for the mismatch between theory and practice is widespread across domains."

(ibid page 8)

Regardless of the positive aspects of situated learning, however, Hennessy also alerts us to some concerns. She acknowledges that although classrooms are "artificial settings" (page 30), they are, nevertheless, the way that our society chooses to organise its education. She goes on to suggest a compromise which she describes as "cognitive apprenticeship" (page 31). This involves learning with, and observing an 'expert' solving problems leading to a very different role for the teacher.

McCormick (1999) is also interested in situated cognition and talks about the educational implications of "practical knowledge" (pages 127 - 133). He looks specifically at problem solving approaches in design and technology and distinguishes between the technology teachers concern with procedural knowledge and the mathematics teachers concern with conceptual knowledge (page 129). He lists differences in the ways the two teachers approach the same topics and outlines ambiguities in terminology resulting from the different contexts in which the subject matter is being taught. He states:

“This is another illustration of the way knowledge is bound with context (.....), a central idea of those who argue for the situated nature of cognition.”

(McCormick 1999 page 129)

This idea has significant implications for our work at RAF Cosford where theoretical concepts are taught in the classroom and later applied in the workplace. It appears that concepts are not only being separated from procedures, but are taught at different times and by different people. This scenario brings together many of the problems outlined by both Hennessy and McCormick. Finally, in his analysis of problem solving, André (1986) distinguishes between “declarative” and “procedural” knowledge forms (Page 70). He sees this as the distinction between “knowing that” and “knowing how” (Page 70), and goes on to suggest that:

“knowing that refers to being able to talk about something; *knowing how* refers to being able to do that something.”

(André 1986 page 70)

He goes on to note that - “acquiring procedural knowledge does not ensure that declarative knowledge will be acquired and vice-versa” (page 70), and he suggests that with this in mind, teachers and instructors should develop learning experiences that lead to the development of both knowledge forms without biasing one or the other. He provides a model (page 71) which he claims will help to achieve this aim though he admits that his approach requires further development and should only be operationalised in particular educational settings.

Potential Relationships between knowledge types.

A brief analysis of the different types of knowledge identified in the previous section, alerts us to the fact that we may possibly categorise knowledge forms into two distinct groups - knowledge which deals with notions and ideas (i.e. concepts), and knowledge which relates to strategies or action (i.e. procedures). For the purposes of this report I shall use Hiebert’s terminology, which defines ‘conceptual’ and ‘procedural’ knowledge. Hiebert (1986) informs us that all mathematical knowledge includes - “significant, fundamental relationships between conceptual and procedural knowledge.” (Page 9) and he goes on to state that:

“Students are not fully competent in mathematics if either kind of knowledge is deficient or if they both have been acquired but remain separate”

(Hiebert 1986 Page 9)

This statement has significant implications for BTEC (NC) assessment. Firstly, it is important to re-state that the majority of BTEC (NC) academic units on the aeronautical engineering course are mathematically based. Consequently, if we are to accept Hiebert’s suggestions, assessment should include and integrate both conceptual and procedural knowledge forms across the range of assessment instruments. A documentary analysis of a cross section of instruments will attempt to clarify whether this is the case and the findings will be reported later in this study.

Silver (1986) further investigates the relationship between conceptual and procedural knowledge and states that:

“when knowledge is used dynamically to solve a problem or perform some nontrivial task, it is the *relationships* that become of primary importance.”

(Silver 1986 Page 181)

He goes on to examine many issues relating to the use of different knowledge types in mathematical problem solving and suggests that although problem solving involves understanding the problem, in many cases the student may proceed by using procedures that bypass understanding processes. (1986 page 191). Here again I see implications for assessment. If it is possible for problems to be solved successfully without a full understanding of the problem, then surely a student may score highly on an assessment by simply adopting algorithmic procedures that ignore concepts. This indicates poor ‘problem’ design and takes us back once more to the E819 study guide. The authors agree with Silver that problems should involve both procedures and understanding suggesting that “when concepts and procedures are not connected in pupils’ learning they may have a good intuitive feel for the subject but not solve problems” (page 67). They go on to note that:

“to provide right answers without understanding reflects an emphasis in teaching on concepts without procedures and vice versa”

(E819 S.G. Page 67)

Finally in this section I turn back to André (1986) who refers to domain-specific knowledge in the solving of problems. He seems to agree that without an adequate amount of conceptual knowledge (or declarative as he describes it) students will be

unable to do much more than - “rotely memorise solutions to problems” and would be “unable to transfer what they had been taught to new situations” (1986 page 66). He suggests that an understanding of concepts, rules, principles and skills is necessary to be a successful problem solver and on this basis - “education must provide learners with an extensive knowledge base if they are to develop problem solving skills” (ibid page 67).

Knowledge and BTEC (NC) Assessment.

The BTEC policy handbook (1993) outlines a variety of approaches to incorporating mathematics into BTEC programmes (page 15). Inherent within these statements is evidence of the BTEC perspective on knowledge, though direct reference to ‘knowledge’ seems to have been overlooked within BTEC publications. Particularly relevant to this study is a set of statements concerning mathematics policy. These statements are reproduced overleaf:

Analysis of these statements gives us some indication of the BTEC view of knowledge. Policy 2, for example, leaves little doubt that BTEC advocate practical problem solving activities and they also indicate that the skills learnt should be transferable and useful for developing models of the “real world.” This would appear to be an example of what Barnes (1988) describes as “knowledge for action” (page 75) and also bears some similarity to what Von Glasersfeld (1987) calls “viable knowledge” (page 12). BTEC go on to state that “mathematical skills should be used in context” and that assessment should “reflect the circumstances in which the skills are used in practice” (see 4 & 5 overleaf). This seems to be in line with the views of Davis (1986) who states that:

“At the elementary levels, mathematics is a description of reality – a description that is sufficiently detailed to give us a considerable measure of control.”

(Davis 1986 Page 266)

2. In all cases mathematics should be:
 - A practical problem solving activity.
 - A set of skills that can be used in a wide range of situations.
 - A powerful means of communicating information clearly.
 - A set of techniques that help develop useful models of the real world.
 3. The mathematical content should:
 - Be clearly relevant to the needs of the employment sector and qualification.
 - Reflect developments in new technology.
 4. Mathematical skills should be developed and used in context, making use of appropriate computational aids. The skills should be incorporated into learning activities throughout the programme.
 5. A variety of methods for assessing mathematical attainment should be used, reflecting the circumstances in which the skills are deployed in practice.
- (BTEC policy handbook. 1993 page 15)

He goes on to examine problem-solving techniques employed by mathematicians and non-mathematicians and advises us that for non-mathematicians:

“In simple arithmetic tasks, understanding the problem nearly always guides you to the method for solving it. Finding the answer is hardly ever a difficult matter. It is only when I try to think of mathematics as writing symbols on paper that I begin to experience difficulties.”

(ibid page 268)

He concludes by suggesting that when learning mathematical concepts:

“Dealing with actual problems should come first. Learning to use written symbols as cheap proxies for reality comes second.”

(ibid page 269)

Not only is this in line with BTEC policy 5, it also seems to reflect the views of the E819 S.G. who note the relationship between the problem solving approach and Piaget’s constructivism. This type of knowledge they suggest is:

“neither exclusively pre-existent nor solely environmentally determined but resulting from an interaction of both.”

(E819 Study Guide page 57)

2. In all cases mathematics should be:
 - A practical problem solving activity.
 - A set of skills that can be used in a wide range of situations.
 - A powerful means of communicating information clearly.
 - A set of techniques that help develop useful models of the real world.
3. The mathematical content should:
 - Be clearly relevant to the needs of the employment sector and qualification.
 - Reflect developments in new technology.
4. Mathematical skills should be developed and used in context, making use of appropriate computational aids. The skills should be incorporated into learning activities throughout the programme.
5. A variety of methods for assessing mathematical attainment should be used, reflecting the circumstances in which the skills are deployed in practice.

(BTEC policy handbook. 1993 page 15)

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“neither exclusively pre-existent nor solely environmentally determined but resulting from an interaction of both.”

(E819 Study Guide page 57)

I have already discussed Hiebert's view of conceptual and procedural knowledge, and both Silver (1986) and André (1986) seem to agree that the best way of achieving a balance between the two types is through a 'problem solving' approach. BTEC's policy seems to reinforce this view, though we must remain alert to Silver's warning regarding 'procedures which by-pass understanding'. As I noted previously, this may result from poor problem design, and could lead to an imbalance between conceptual and procedural knowledge.

Summary of Literature Review and Evolution of Research Questions.

My review of the nature of assessment has as the centre of its focus the 16 bi-polar constructs identified by Harris & Bell (1996 page 97). The 16 constructs provide a useful basis for the analysis and labelling of assessment tools and procedures and will offer a framework for my own analysis during the early stages of this research.

BTEC/EDEXCEL have become great advocates of criterion referenced approaches to assessment (See BTEC/EDEXCEL 1998). They suggest a paradigm that brings to mind what Butterfield (1995) describes as the 'continuum' model, and which rises above the simplistic can/can't philosophy to bring in 'levels' or 'degrees' of competence. Furthermore, BTEC/EDEXCEL have become active in the development of curricula that mix and integrate both product and process objectives. Reece & Walker (1995) define process based curricula as being focused upon "student activities" and the "teaching and assessment of transferable skills which are common to a number of subject disciplines" (1995 - Page 239). This appears to underpin the BTEC/EDEXCEL philosophy as they place great emphasis upon 'common skills' assessment on each of their First, National Certificate and Higher National Certificate programmes. Cashian (1995) examined the BTEC approach to common skills and acknowledged that it is based upon a student centred philosophy and it is implemented in one of five different ways depending upon institutional constraints.

The remaining bi-polar constructs identified by Harris & Bell (1996) have varying degrees of significance within BTEC (NC) assessment. Rowntree (1996) examines the concept of formal and informal techniques suggesting that procedures in general range

from “the very informal, almost casual, to the highly formal, even ritualistic” (page 5). Ecclestone (1996) defines the difference between formative and summative techniques suggesting that formative assessment does not contribute to “formal grading or certification” (page 173), and Rowntree (1996) writes about learner judged material and the implications of ‘self assessment’. The strand 1 review is concluded with a list of definitions regarding the constructs that are considered relevant to this study. Within the context of the definitions offered, there remains a need to identify more closely the nature of BTEC assessments and how these may be related to an overall set of principles’. The strand 1 research questions which are published below, will enable this process to proceed within the theoretical framework of this investigation.

Strand 1 Research Questions:

1. What are the essential characteristics of the assessment scheme on the BTEC (NC) academic units?
2. How do the different assessment procedures interrelate to form a coherent assessment strategy for each BTEC (NC) academic unit?

The authors of the E819 study guide (OU – 1990), emphasise the fact that validity takes many forms. For the purposes of this study, strand 2 will focus upon the concepts of ‘construct’ and ‘content’ validity and will lay the foundations for more detailed research as the study evolves.

Construct Validity.

Fletcher (1987) links construct validity to the “theoretical basis” of the test (page 221), and Reece & Walker (1995) write about the extent to which it is “appropriate” (page 361). The authors of ‘Better Schools’ (1985) take this a step further and consider “fitness for purpose” and the “potentially damaging side effects” of assessment (page 51). They also investigate links between ‘construct’ and ‘content’ stressing that assessment must be consistent with the “aims and objectives embodied in the curriculum and the teaching strategies employed” (page 51). Denvir (1989) who explores the concept of assessment purpose investigates some of these matters. It seems that there are palpable links between assessment purpose, the appropriateness of the assessment procedure and the theoretical basis of the assessment instrument. All of these issues impact upon the construct validity of the overall assessment scheme.

On a different note, Dawson & Thomas (1972) warn us about the “psychological qualities” measured by some forms of assessment (page 25). They suggest that certain explanatory constructs influence “performance on the test” (page 25), and as a consequence, may reduce construct validity. These issues are linked to Reece & Walkers (1995) work that explores the relationship between assessment and learning domains. They come up with a framework, which suggests possible assessment methods for testing different types of cognitive objective. This provides a starting point for evaluating construct validity and should prove useful for this research.

Content Validity.

On the issue of ‘content validity’, Reece & Walker (1995) suggest an assessment specification to ensure that each assessment samples the content of the course or topics specified, and the range of abilities encompassed by the learners. Dawson & Thomas (1972) draw our attention to a different set of weaknesses concerning student choice. By offering students a choice of 5 questions from 9 on a summative test they stress, we are introducing 126 combinations. The implications seem obvious, theoretically, 126 students could each sit a different paper with a different content from that of their peers. This effectively renders comparison of performance meaningless, and any statistical work in itself invalid.

Finally, we have the issue of ‘weighting’. This takes us back to Reece & Walkers assessment specification (1995 page 363). Marks allocated to a particular topic or outcome during summative assessment should reflect the hours allocated to that topic or outcome within the syllabus. Weightings have clear implications for content validity and may lead to an invalid system of assessment in some cases.

Strand 2 Research Questions.

1. Does the assessment scheme for the BTEC (NC) academic units have construct validity?
2. Do the assessment instruments which make up the scheme have content validity in terms of the outcomes tested?
3. Is there correlation between marks allocated to a particular outcome during summative assessment and hours allocated to that outcome within the syllabus?

BTEC/EDEXCEL (1998) advocate the principles of 'experiential learning' for practical assignment work, a philosophy based largely upon the work of Kolb (1984) who drew our attention to the experiential learning cycle. Kolb's learning cycle attempts to integrate 'learning' and 'problem solving', two concepts that previously had been considered separate and distinct from each other. The model is not without critics, however, and Schlesinger (1996) questions whether learning is a cycle at all, doubting the behavioural ethos on which Kolb's model is based. Other concerns are reviewed during strand 4 of this study. André (1986) examines problem solving and suggests that as yet, it is an area that is underdeveloped. He goes on to examine several approaches to problem solving that include the behavioural model and an information processing approach. He acknowledges the work of Thorndike (1898), Skinner (1986) and Mayer (1983), who among others too numerous to mention, have each contributed to behavioural theory. Even so, his main review focuses on the work of Cegelka & Lewis (1983), whose 'applied behavioural analysis' seems similar to the BTEC approach and the RAF Cosford model.

Larkin (1983) examines information processing and alerts us to "levels of representation" (page 180). Wood (1988) relates the model to 'expertise'. He appears to suggest a relationship between information processing and social constructivism and moves on to consider constructivism in light of Piagetian and Vygotskian theories. Roth (1999) also examines Vygotskian social constructivism and notes the relationship between 'novices' and 'experts' which seems to be central to the approach. There seems to be agreement that social constructivism relies for success on accessing the learners 'Zone of Proximal Development' (ZPD) (Vygotsky (1978), Britton (1987), Wood (1988) and Roth (1999)). If this can be successfully achieved, it provides opportunities for learners to reach their 'assisted performance level' rather than the lower unassisted level that may otherwise be achieved.

Strand 3 Research Questions.

1. What theory(s) of learning underpin the BTEC (NC) academic units at RAF Cosford?
2. Is there evidence of 'experiential learning' as advocated by BTEC (1998)?
3. What are the implications of the strand 3 findings for the validity of the BTEC (NC) assessment scheme?

Whatever the underpinning theory of learning or the instructional style of the lecturer, it seems apparent that the ultimate success of a learning experience, or the appropriateness of an assessment instrument, may be influenced by the individual learning style of the student. There is much discussion regarding the relationship between the individual learning style of the student and their overall cognitive style. Curry (1983) uses the analogy of a 'style onion' suggesting that individual learning style exists somewhere in the second strata as part of the learners approach to information processing. Messick (1976) reinforces this idea suggesting that cognitive style exists at a higher level than strategies for problem solving or learning. Sadler-Smith (1997) describes learning style in terms of Kolb's model of experiential learning and agrees that it represents a small element of the individuals cognitive style. Overall there seems to some agreement that 'cognitive style' is an umbrella term that encompasses 'learning style' as one of its component parts. Riding & Cheema (1991) have a slightly different perception referring to two cognitive style families. These they define as 'wholist-analytic' and 'verbaliser-imager' and they suggest that each individual falls into one of nine categories based upon these two bi-polar dimensions.

Kolb (1976) developed a system for identifying an individuals learning style, which he named the 'learning style inventory' (LSI). The model was subjected to a number of investigations to determine its reliability and validity (see Geller (1979), West (1982), Talbot (1985), Sims et al (1986), Wilson (1986) and Willcoxson & Prosser (1996)). In response to the concerns raised Honey & Mumford (1986) developed a different approach based upon a 'learning styles questionnaire' (LSQ). They placed learners into four categories (or somewhere between), labelling them as either activists, reflectors, theorists, pragmatists or a hybrid dictated by their score on the four learning style dimensions. This simple system has found favour with management specialists and represents a popular approach to identifying an individuals learning style for the purposes of management training. Caple & Martin (1994) and Schlesinger (1996) have expressed concerns about the behavioural ethos of the model, but studies regarding reliability and validity remain positive (see Allison & Hayes (1988/1990)).

For the purposes of this investigation, individual learning styles will be considered as the lower level heuristics defined by Curry (1983). If we accept that individuals fall into one of the categories defined by Honey & Mumford (1986), then the implications for BTEC (NC) assessment require urgent examination. Certain types of learner may be more suited to particular types of assessment than others. This highlights issues of validity and the appropriateness of certain assessment instruments. This study aims to investigate such issues within the framework of the following questions:

Strand 4 Research Questions:

1. Are certain types of learner either advantaged or disadvantaged during summative assessment on the BTEC (NC) academic units?
2. What are the implications of individual learning styles for the validity of the BTEC (NC) assessment scheme?

Lerman (1983) suggests two perspectives on mathematical knowledge referring to – mathematics as a body of knowledge or as a way of thinking (page 57). Hiebert (1986) takes things further and examines the relationship between conceptual and procedural forms of knowledge. He provides some useful definitions and goes on to distinguish between two levels at which relationships may be established. The levels depend upon the degree of “abstractness” (page 5) or the context specific nature of the knowledge under consideration. Von Glasersfeld (1987) writes about “viable knowledge” (page 12), seeing it as operative and reflective and Barnes (1988) distinguishes between “educational knowledge and knowledge for action” (page 75). He goes on to consider what he calls theoretical knowledge and knowledge that is relevant to everyday living suggesting that problem solving leads to a more useful form of knowledge than traditional teacher centred approaches (page 77).

Hennessy (1993) advocates “situated cognition” for reducing the gap between theory and practice (page 8). The basis of her philosophy is that “formal teaching lacks relevance” (page 5) and does not relate to everyday life. McCormick (1999) seems to agree with her and refers to problem solving in design and technology. He distinguishes between the technology teachers concern with procedural knowledge and the mathematics teachers concern with concepts (page 129), noting that the differences illustrate how knowledge is bound with context.

André (1986) differentiates between 'declarative' and 'procedural' forms of knowledge. He likens the difference to that between "knowing that" and "knowing how" and advocates that instructors should develop learning experiences that feature both forms without biasing one or the other. BTEC (1993) provide some indication of their perspective on knowledge but they do not write about it specifically and we must draw our own conclusions based upon current BTEC publications. Their present position indicates a problem solving approach and may be likened to Von Glasersfeld's description of 'viable knowledge' (1987).

Finally, Hiebert (1986) examines the relationship between different types of knowledge concluding that both conceptual and procedural knowledge must be acquired to achieve competence and they must not remain separate (page 9). Silver (1986) agrees that the relationship between knowledge types is of primary importance during problem solving and André (1986) states that problem solving without an adequate amount of 'declarative' knowledge will inhibit the transfer of what has been taught to new situations. In essence, the types of knowledge, the balance of knowledge and the relationship between different knowledge forms seems crucial to the success of a learning experience and the validity of an assessment process. This research study aims to investigate the types of knowledge that are being tested during BTEC (NC) summative assessment at RAF Cosford and its relationship with the individual learning styles of the students. If it can be proved that students with a particular learning style are disadvantaged due to the types of knowledge being assessed, then there are possible implications for the validity of certain assessment instruments that must be addressed.

Strand 5 Research Questions:

1. What types of knowledge are being tested during BTEC (NC) summative assessment at RAF Cosford?
2. Is the balance between different forms of knowledge appropriate?
3. How do students with a particular learning style perform when faced with tasks involving the various types of knowledge identified? How does this impact upon the validity of the assessment scheme?

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Synopsis of Research Questions.

Strand 1.

1. What are the essential characteristics of the assessment scheme on the BTEC (NC) academic units?
2. How do the different assessment procedures interrelate to form a coherent assessment strategy?

Strand 2.

1. Does the assessment strategy for the BTEC (NC) academic units have construct validity?
2. Do the instruments that make up the scheme have content validity?
3. Is there correlation between marks allocated during summative assessment and syllabus hours?

**THE NATURE OF
ASSESSMENT, ITS VALIDITY
& ITS RELATIONSHIP WITH
LEARNING ON BTEC (NC)
COURSES IN ENGINEERING
PRINCIPLES.**

Strand 3.

1. What theory(s) of learning underpin the BTEC (NC) academic units at RAF Cosford?
2. Is there evidence of experiential learning as advocated by BTEC (1998)?
3. What are the implications of the strand 3 findings for the validity of the BTEC (NC) assessment scheme?

Strand 4.

1. Are certain types of learner either advantaged or disadvantaged during summative assessment on the BTEC (NC) academic units?
2. What are the implications of individual learning styles for the validity of the BTEC (NC) assessment scheme?

Strand 5.

1. What types of knowledge are being tested during BTEC (NC) summative assessment at RAF Cosford?
2. What is the relationship between assessment, knowledge and individual learning styles?
3. How do the findings from this area of research impact upon the validity of the BTEC (NC) assessment scheme?

Figure 2.2

Chapter 3: Methodology.

The research paradigm to which this study belongs has its roots in the 'case study' tradition, yet combines methodologies that transcend the quantitative/qualitative divide. The term 'case study' embraces a range of educational research, which differs in its scope and intensity but retains a number of unique characteristics. Hammersley (1999 Page 2) provides a schematic comparison of case studies with experimental and survey approaches. Some of the features that he identifies may be recognised within this enquiry. One characteristic that Hammersley defines as being present in "virtually every sense of the term" (1999 Page 1), is that case study implies the study of a small number of instances, and in some circumstances he notes, just one case may form the focus of an investigation. This paper represents a study of this sort, where one case, the N^o1 School of Technical Training at RAF Cosford, is investigated within a pre-determined theoretical framework. The methods designed for each individual strand of the framework are explained in detail on the following pages of this report. It is appropriate to state at this point, however, where this study sits in the current debate, and how the positivist and anti-positivist philosophies interact to form a coherent methodology for research.

Margaret Bird (1992), notes that until recently educational researchers have lived in a divided world, with quantitative researchers on one side of the fence, and qualitative researchers on the other, both viewing each other suspiciously and refusing to integrate. She goes on to outline an approach that she adopted to carry out a case study at the 'Open College of South London' in 1987. Her methodology combined the two approaches within one piece of research, in an attempt to break down the barriers between the two contrasting schools. During the intervening years many educationalists have combined quantitative and qualitative techniques in pursuit of their research aims. Such studies have enjoyed varying degrees of success, and it would be fair to say that though their original aim would have been to harness the benefits of the two approaches in a complementary way, often they have also provoked criticisms from either side of the methodological divide. Even so, attitudes are changing, and a review of contemporary literature seems to reflect some convergence between the two opposing factions. The authors of the E835 study guide (OU 1996) state that:

“Much educational enquiry uses both quantitative and qualitative methods, and there are good reasons for believing that these can complement each other in important ways”

(OU 1996 page 16)

Though recent educational research is beginning to reflect this trend, there are cases of an integrated approach that precede Bird's Open College study. One such example is evident from an evaluation study in Solihull that is reported by Turner & Clift (1987). The researchers in this case used questionnaires as their primary means of collecting data and went on to use traditional statistical techniques for the purpose of analysis. Later, they followed up their questionnaire responses by interviewing respondents to “explore some issues further” (1987 page 147), a clear case of quantitative and qualitative techniques being combined in the search for further meaning and understanding.

Mary James (1987) carried out a study into self-evaluation activities that had been carried out by practitioners in their own schools. As part of her research she analysed the methodologies employed by a sample of ‘teacher researchers’ and concluded that two distinct approaches emerged from the data (1987 page 178). She describes these as ‘meeting based’ and ‘research based’ and went on to define them as quantitative and qualitative in terms of their theoretical perspective. She notes that although these two approaches to research were dominant, many of the research activities sampled could best be described as “eclectic” (1987 page 178). She goes on to state:

“These two research approaches seem to be associated with positivist and interpretative theoretical perspectives, respectively ... the eclectic mode suggests a lack of commitment to one, to the exclusion of the other.”

(James.M. 1987 Page 178)

Walker (1978) examined the conduct of educational case studies and concluded that:

“The best case studies transcend the boundaries between art and science, retaining both coherence and complexity”

(Walker.R. 1978 Page 173)

He notes that recent educational case studies are often seen as belonging to the qualitative school and he suggests that this perception is probably deceptive stating that:

“Superficially case study is often set against quantitative research as belonging to a different ‘paradigm’, but in some ways this distinction is misleading, the case study worker is often more ‘quantitative’ in orientation than is realised.”

(ibid Page 177)

So what is the justification for bringing together what some researchers still believe to be contrasting and contradictory research paradigms within this case study? I have already noted some of the benefits that may be derived from using quantitative techniques in the first instance, followed by qualitative analysis in the search for deeper understanding. Examination of the five strands of research that make up this study provides further rationalisation for this approach. Strand 1, which investigates the ‘nature’ of assessment, relies entirely on qualitative, interpretative techniques that include documentary analysis and informal/semi-formal interviews. As we move on, however, strand 2, which focuses on construct and content validity, represents a prime example of eclecticism. This is particularly evident during work on ‘content’ validity which begins with a positivist approach based upon statistical mapping and nomographs before employing interpretative methodologies to focus on areas of ambiguity, or where further probing was required in the search for improved understanding. The eclectic approach is carried forward to strand 3, where qualitative documentary analysis, non-participant observation and systematic analysis are all combined in pursuit of a common purpose. Strand 4 is essentially quantitative employing traditional statistical techniques to search for relationships between individual learning styles and assessment performance and the eclectic ethos returns in strand 5 where again positivist and interpretative techniques are combined during an integrated approach to data collection and analysis.

Purists may label such an approach as lacking methodological integrity, however, as Atkinson and Delamont (1985) acknowledge:

“Methodological sophistication is not a marked characteristic of the genre.”

(Atkinson & Delamont 1985 Page 208)

What they seem to be suggesting is that fitness for purpose is more important than trying to piece together a methodology that fits neatly into a recognised ideal.

Adelman et al (1980) seem to agree stating that:

“‘Case study’ is not the name for a standard methodological package.....”
(Adelman et al 1980 Page 48)

They go on to note that case studies should not “be equated with observational studies” and that they are not simply “pre-experimental” (ibid Page 48). In short, what they say seems to agree with Atkinson and Delamonts suggestion that:

“It is remarkably difficult to provide anything approaching a definitive account of case study approaches”
(Atkinson & Delamont 1985 Page 206)

In summary the eclectic approach engendered within this case study may be justified by the nature of the research questions that are under investigation, and the complex interrelationships that are bounded by the theoretical framework for the enquiry. It seems appropriate now to focus on the techniques and methodologies that have been employed at each stage of this investigation so as a clearer picture may emerge.

Strand 1 - What is the Nature of Assessment on BTEC (NC) Courses in Engineering Principles?

This initial strand of research, which is fundamental to the study as a whole, involved the collection of data on two fronts. In the first instance I collected documentary evidence across the four subject areas that comprised a range of assessment instruments and papers from the squadron assessment bank. This data was supplemented by assessment materials donated by individual lecturers many of whom had designed their own instruments for the purposes of revision and consolidation. This mass of physical evidence was further complemented by data from semi-formal interviews with lecturing staff. Many of these interviews took place in the tea bar during break times and their purpose was primarily to establish individual strategies for formative, informal assessment, as these practices form an important part of the overall assessment strategy.

Once I had completed my data collection, documentary evidence was categorised under subject headings and an assessment 'profile' was established for each of the four modules under investigation. It was evident that the summative aspects of assessment followed a linear progression through each module and formative techniques such as consolidation and revision papers could be placed into their respective positions relative to the summative tools. Formative techniques that were highlighted during semi-formal interviews were slotted in to complete the jigsaw.

On the basis of the above, 'flow diagrams' were created to give an overview of assessment on each of the four modules. These were validated using a technique described by McCormick & James (1990) as 'respondent validation'. This procedure required feeding my flow diagrams back to interview respondents and colleagues to confirm their accuracy. Comments resulting from this process were then logged and amendments made as necessary. Further respondent validation was carried out to validate the changes until there was widespread agreement that the diagrams were accurate and provided a good overview of assessment practice in each of the four subject areas.

Strand 2 – The Validity of the BTEC (NC) Assessment Scheme in terms of ‘Construct’ and ‘Content’.

The validity of assessment is an issue that has been of major concern to teachers and educators during the past 20 years. For the purposes of this strand of research I have focused upon two aspects of validity that I believe to be particularly relevant to the aims of this study - namely, ‘construct validity’ and ‘content validity’. Each of these types of validity were reviewed in the previous section of this report and other issues that impact upon the assessment strategy as a whole will be considered in subsequent strands of research.

Before explaining my methodology for exploring these issues it seems appropriate to re-state a definition for ‘construct validity’ that may be assumed for the remainder of this study. Construct validity asks the question - Is the assessment instrument being used, a suitable means of assessing the skills and objectives that it purports to test? To investigate this question my first task was to design a strategy for ‘sampling’. This was necessary due to the huge amount of documentary material that had been collected during strand 1. My sampling procedure was based upon what Wragg (1987) described as “Stratified Random Sampling” (page 5). This method required the grouping of assessment instruments into sub-categories to ensure that all the different types of instrument that make up the assessment strategy are ultimately included in the sample. Each instrument in each sub-category was then given a number and the sample for the study was selected by extracting two instruments from each sub-category using a ‘random number generator’. This approach ensured that a good cross-section of assessment materials were included in the sample while also retaining an element of randomness across the sample as a whole. My approach to strand 2 sampling is shown diagrammatically overleaf.

Once the sample was selected, the different assessment instruments were analysed in terms of the bi-polar constructs that were brought to our attention by Harris & Bell (1996) (see literature review - page 6). This was achieved through a tabular approach that gave me some indication of whether the instruments being used were suitable for their purpose. Related to this was my second question, does the test measure what it purports to measure? To gain some insight into this issue, I carried out a qualitative

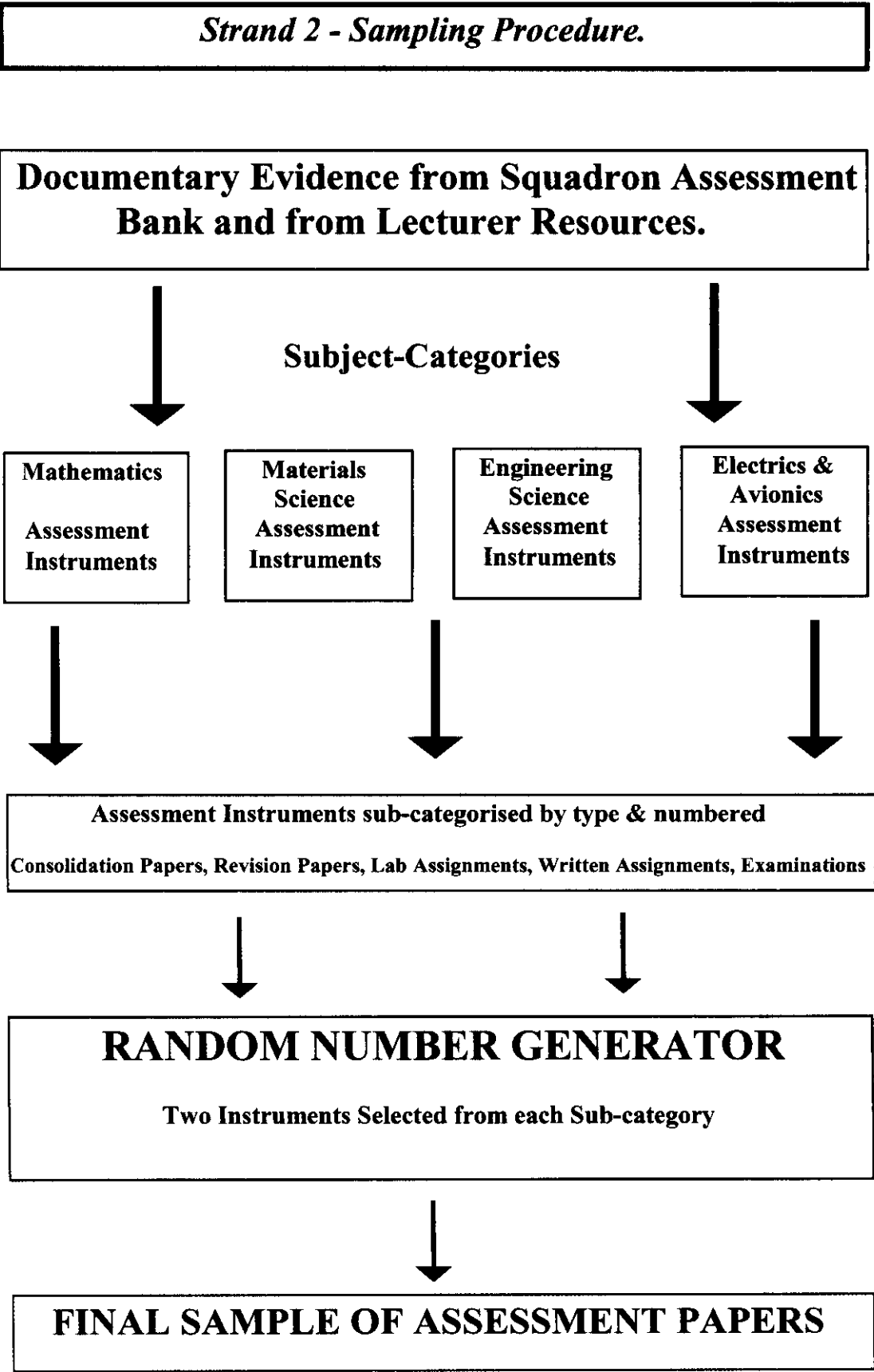


Figure 3.1

analysis of several assessment questions selected at random from my sample. This involved actually doing the questions myself and then breaking the answers down to ascertain whether they were assessing what they claimed to assess. Though this area of research was based largely on my own judgement, the results of the exercise alerted me to the possible consequences of poor question design and its implications for construct validity.

Moving on to 'content validity', my initial approach was more scientific and used nomographs for mapping the assessment content to the relevant objectives within the instructional specification. This proved to be a successful methodology as the finished graphic made it easy to identify any objectives that were not being tested and also provided evidence if questions were found to be testing material that was not linked to an objective in the syllabus. An example of a nomograph that was designed for this purpose is included as appendix (F) at the rear of this report.

Having found nomographs successful in the above context, I decided to adopt a similar approach to investigate 'weightings'. This area of research related marks awarded to a question during assessment to syllabus hours for the objective(s) covered. I hoped that correlation between these two variables would be within $\pm 2\%$, though the results showed that this was not always the case. An example of a nomograph designed to test 'weightings' is included as appendix (G) at the rear of this report.

Finally on the issue of 'content validity', I turned my attention to the concerns of Dawson & Thomas (1972) who alerted us to the fact that introducing choice into assessments has profound implications for 'validity'. To research this aspect of assessment I adopted a quantitative approach that was designed to ascertain how many different 'combinations' were inherent within a single assessment. Mathematical factorials and mapping matrices were used for this area of investigation followed by a qualitative analysis of the results.

Strand 3 – Learning Theory and Approaches to Instruction on the BTEC (NC) Academic Units.

My third strand of research attempts to identify the theoretical position held within the Principles and Advanced Training Squadron (PATs) and to investigate how this impacts upon instructional approaches within the classroom. In the initial stages, this area of research was largely based upon documentary evidence that was subjected to a detailed qualitative analysis in the search for evidence. The richest source of data was the 'instructional Specification' (I.S.) which not only contains the subject content for each module, but also sets out precise details for teaching methodology, lists resources, details assessment procedures and outlines many other issues relevant to the teaching of individual topics. The document is in a standard format and there is an I.S. for every BTEC module taught at RAF Cosford.

In addition to my qualitative analysis of the instructional specification, assignments also provided data for this area of research. It was established within my literature review that BTEC are great advocates of experiential learning and suggest that assignments are a good way of putting experiential learning techniques into practice. I decided to test a cross-section of assignments at RAF Cosford in an attempt to ascertain whether the experiential learning ethos had been adopted. I designed an evaluation system for this purpose that not only focused upon the experiential ethos, but also yielded data on other important aspects of assignment design such as content validity, assessment procedures and opportunities for group and individual work. There are in fact 16 criteria against which I evaluated a sample of assignments and each criterion was awarded marks within the range 0 - 5. Scores were then recorded on a polar scale providing a graphical representation that clearly shows areas of weakness. A 'perfect' assignment would score 80 marks overall resulting in a regular hexadecagon on the polar graph. In addition, criteria may be broken down into blocks of four for further analysis of specific areas. My systematic approach to assignment evaluation comprises three sheets and is included as appendices (H) to (J) at the rear of this report. Two colleagues and myself, who each evaluated three assignments using the system, piloted the model for reliability. Analysis of the results from the piloting exercise revealed a high degree of correlation between the evaluation results.

Finally in strand 3, I attempted to examine instructional variations within the classroom. My hypothesis was that regardless of the underpinning theory of learning within the Principles and Advanced Training Squadron, there remains scope for individual lecturers to adopt their own preferences in terms of instructional technique. On this basis, a diverse range of approaches to instruction might be evident at classroom level. This is directly linked to the cognitive style of the student and their individual preferences and can have a profound effect upon learning and assessment. To test my hypothesis I adopted an approach that was based upon non-participant observation. This involved observation of three lessons, delivered by different lecturers, all of which had as their focus the same objectives within the instructional specification. An observation schedule was designed for this purpose and is included as appendix (K) at the rear of this report. This data was supplemented by additional field notes where necessary and the analysis attempted to identify different approaches to instruction evident in each case.

Strand 4 – The Relationship between Assessment Performance and Individual Learning Styles during BTEC (NC) Assessment.

This strand of research explores the relationship between assessment and individual student learning styles. At the outset, my principle aim was to identify individual learning styles in a sample of students at RAF Cosford, in an attempt to establish whether there is a relationship between individual learning style and ultimate success or failure on a range of different assessment instruments. Within my literature review I investigated two widely used approaches to the identification of ‘learning styles’, namely Kolb’s model, the LSI (1985), and Honey & Mumfords alternative approach, the LSQ (1986). Kolb’s model has been criticised for lack of validity (see page 41 of this report), and while Honey & Mumfords model offers a credible alternative, I myself questioned the mathematical validity of the scoring system on the grounds that it is imprecise and fails to use all the information available. As a result of these criticisms, I have developed my own scoring system based upon ‘vector theory’, which I shall use with Honey & Mumfords LSQ for the purposes of this study. The system I have developed has been validated by 2 mathematics specialists at RAF Cosford, and though neither considers themselves to be experts in the area of education, both were happy with the mathematical model and confirmed its validity.

Following mathematical validation, my new model was piloted on a sample of 3 students within the 'Principles & Advanced Training Squadron' at RAF Cosford. Scores were obtained using Honey & Mumfords original LSQ (1986) and these were transferred onto a set of axes in vector form. The resultant on each bi-polar dimension (action & analysis) was then worked out to give us a modulus and argument for each individual, and though I knew little about the significance of the modulus at that point, I was able to categorise each of the three individuals broadly into their correct learning category (i.e. activist, reflector, theorist or pragmatist). As I had no parameters to work with at that stage, I decided to leave any work on the significance of moduli until I had completed the study with a full sample of 100 students. This would then enable me to establish a 'range' for the sample, and provide data from which I could accurately decide what I was going to class as 'significant' or otherwise once a learning style was established for each individual.

On the basis of the data collected, I decided to carry out analysis on 4 levels. My sample of 100 students gave a range of moduli that varied from zero at one extreme to a maximum of 17.69 at the other. The vast majority of students fell within a range of 3 to 7, however, with very few of the sample showing a modulus of less than 2, and only a small number with a modulus of 12+. I decided to call learners with a modulus of less than 2 'hub-learners'. My hypothesis was that these individuals may be very adaptable, and could prove to be strong on a range of different assessment instruments. I then came up with a range for my level 3 learners. These individuals will have a definite tendency towards one of the four learning styles, but the significance will be 'low', as indicated by their low modulus value. These learners fall within the range 2 - 4.99. The level 2 learners have a more significant preference towards one or other of the four learning styles. These learners fall into the range 5 - 7.99, and I consider this range to be of moderate significance within the parameters being used. Finally we have the level 1 learner. These individuals have a very significant preference for a particular learning style as shown by their high modulus value of 8+. A diagrammatic summary of learning style significance based upon this approach is included as figure 3.2 overleaf.

Significance of Individual Learning Styles.

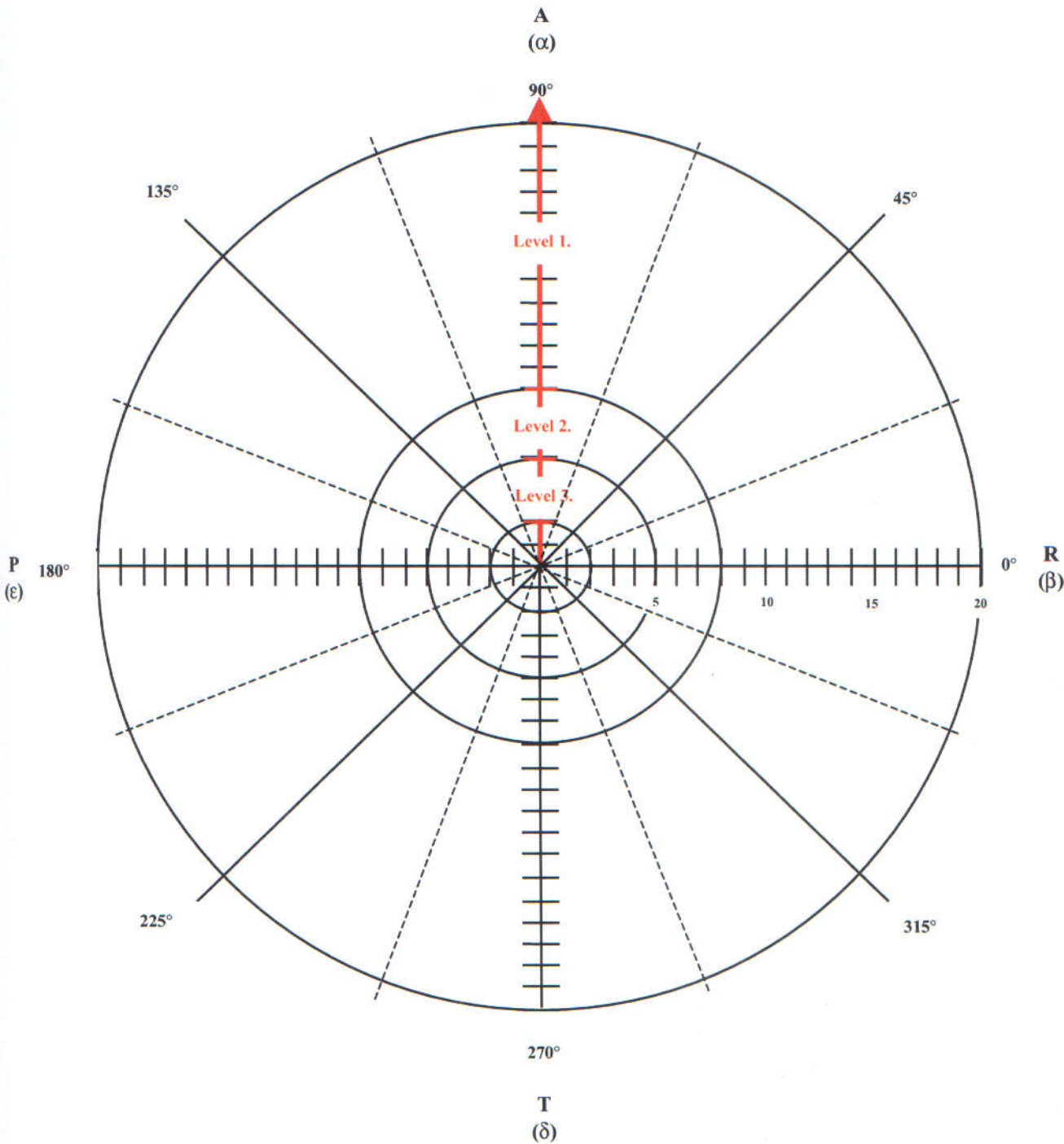


Figure 3.2

Examination of figure 3.2, shows that each of the four learning styles has been denoted by a greek symbol - activists (α), reflectors (β), theorists (δ) and pragmatists (ϵ). The reason for this is to avoid confusion between the numbers attributed to each learner and the individual learning style identified. For example, each learner included in the sample is identified by a number such as A10, where the 'A' identifies the trade of the learner (ie. airframes)⁴ and the '10' tells us their number in the sample. If this particular learner turned out to be a level 3 activist, they could then be labelled as 'A10 α 3'. Other trade letters are 'P' for propulsions, and 'W' for weapons, hence, W9 ϵ 3 shows that learner 'weapons 9' is a level 3 pragmatist, P10 δ 1 tells us that learner 'propulsions 10' is a level 1 theorist and so on. You will also note from figure 3.2 my argument range for each of the four learning styles. Activists (α) are considered to be those individuals with an argument that falls in the range 45° to 134°. As we have seen, the significance of their activist preference is determined by their modulus value. Pragmatists (ϵ) fall within the range 135° to 224°, theorists (δ) 225° to 314°, and finally, reflectors (β) 315° to 44°. The further we deviate from the middle value in each of the four ranges the less the individual concerned depends upon a particular style. Consequently, we must take careful note of both the modulus and argument before making any assumptions about the individuals in this study.

Having established the theoretical basis of my scoring system, I shall now outline how my research progressed. Collection of data took place on two fronts. Firstly there was the data concerning individual learning styles, the theoretical basis of which is explained above. This involved a sample of 100 students who were selected in accordance with several criteria. It should be understood at the outset that my choice was restricted to the students who were at RAF Cosford at the time the study took place. The majority of courses passing through Cosford are always 'airframes' students; consequently, this is reflected in the sample. Out of the 100 students who were asked to complete the LSQ, 54 were airframes students. As already explained, these are denoted by a prefix 'A'. In addition to airframes students, the sample comprised 16 propulsions students (P), and 30 weapons students (W). Avionics and Electrical students were not included in the sample as they follow a different course

⁴ The trade of the student (i.e. airframes, propulsion, weapons etc) has no direct bearing on the research as all students follow the same academic pathway - it is simply a method of identification.

profile. This means they sit different assessment papers; hence, they were of little value to this study. My sampling technique is shown as figure 3.3 overleaf:

Once the LSQ had been completed by the full sample of 100 students, I began 'scoring' each individual to ascertain the modulus and argument value for each individual learner, I was then able to categorise them under one of the four main learning styles within the limits outlined above. I colour coded each learning style, and plotted each individual result onto a set of polar axes to see whether there were any significant 'clusters' within the sample, and then went onto split each group of learners into the four levels mentioned previously.

I now required the assessment results for each of the students who took part in the study, and I was able to obtain print outs for each of them from the BTEC 'cert' system⁵. Most of the results were recorded as a percentage, hence, my next task was to convert these into pass (P), merit (M), distinction (D) and fail (F) grades using the bands: 0 - 49% (F), 50% - 64% (P), 65% - 84% (M) and 85% - 100% (D).

There were two reasons for using the wider grade bandings as an alternative to percentages; firstly, the hypothesis I was testing was that there would be correlation between certain learning styles and success or failure on certain types of assessment. This was never going to be an exact science with all the other factors that come to bear, consequently, any attempt to group similar learners and then find that their assessment scores were within a couple of percent of each other was always going to be doomed to failure. The wider grading bands provided far more chance of establishing a relationship. Secondly, using the grade bandings is more in line with current BTEC/EDXCEL thinking. They are advocating that any use of numbers or percentages should be completely eradicated from assessment, and following recent discussions with the BTEC 'external verifier' RAF Cosford is moving firmly in that direction.

⁵ The 'cert' system is a computer management package for tracking students and recording assessment results.

Strand 4 - Sampling Procedure.

COURSES AT RAF COSFORD - SEPTEMBER 1999

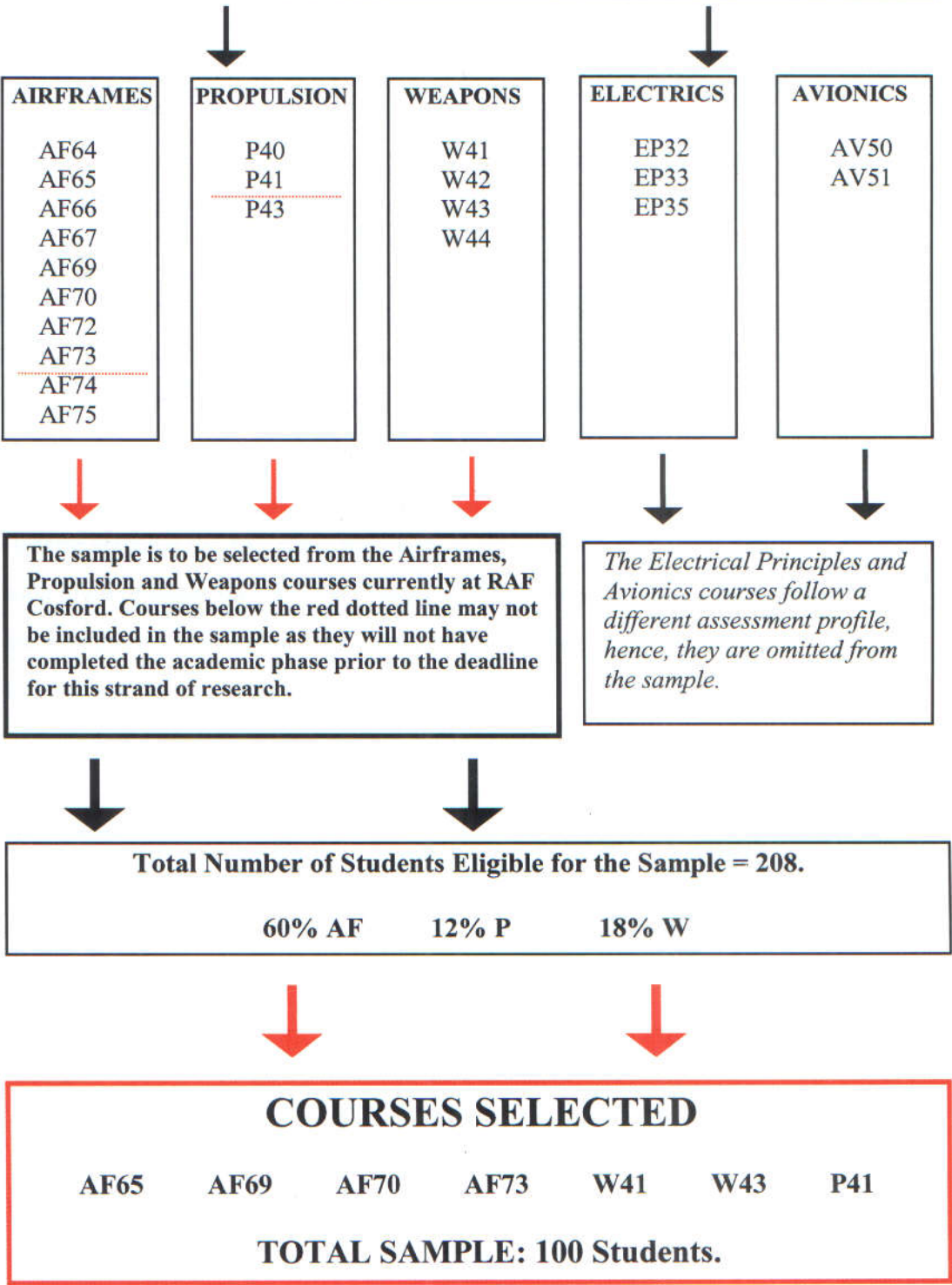


Figure 3.3

I was now ready to start mapping the assessment results to individual learning styles. I used five assessment scores for this purpose and each may be identified by their RAF Cosford code. These are listed below with a description of the assessment to which they relate:

- AB100 Mathematics mid-phase examination.**
- AB102 Mathematics end-phase examination.**
- AB598 Materials science written assignment.**
- AB602 Engineering science laboratory assignment.**
- AB604 Engineering science examination.**

These five assessments were selected for a number of reasons. Firstly, they were common to all trades; hence, the full sample of 100 students could be used in the study. Secondly, they gave me a cross section of different types of assessment which students undertake - examinations, written assignments and laboratory assignments.

Having selected the five assessment episodes, I then completed a mapping matrix for each level of research. This involved a simple procedure that would enable me to identify any ‘patterns’ for particular types of learner. An extract from my level 1 activist matrix is reproduced as table 3.1 below:

Activist (α) Level 1.

Student N^o.	AB100	AB102	AB598	AB602	AB604
A18	P	P	P	P	M
A48	M	P	M	P	P
A50	F	P	M	P	F
A54	P	P	M	P	P
A56	P	P	M	M	P
A59	P	M	P	P	M
P12	M	M	P	M	M

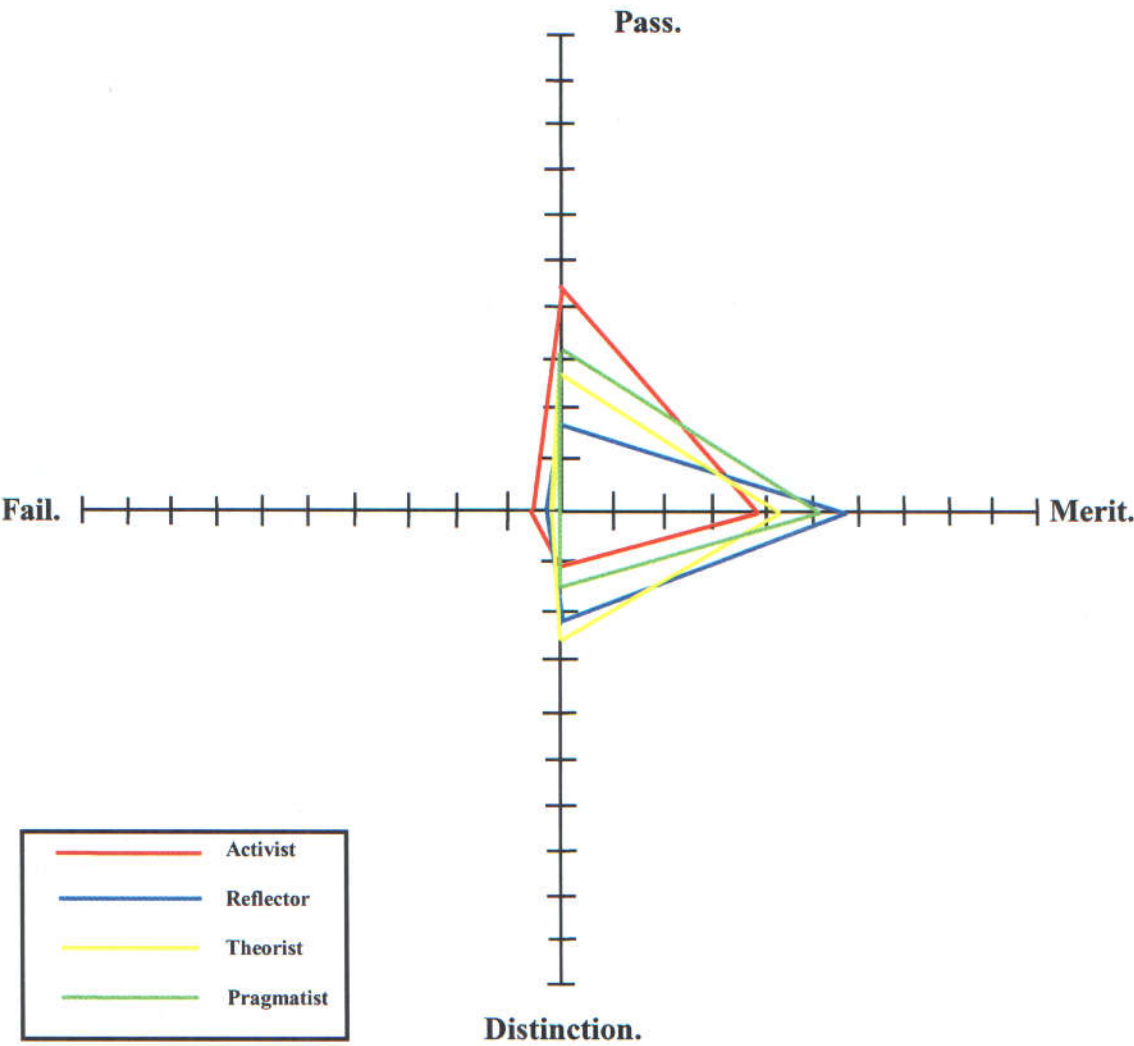
Table 3.1.

Once I had constructed my mapping matrices, I highlighted each grade using a colour coding system. This made it easier to visually identify 'patterns', as a dominant or changing colour was easy to distinguish. I also worked out percentages of each grade obtained both overall and for individual assessment instruments. This served much the same purpose as the colour coding, but provided a more accurate analysis. Once I had calculated the percentages I plotted the results for each of the four learning styles onto a set of axes as an extra means of visually identifying a changing pattern as we moved from one style to another. An example of my approach is included as figure 3.4.

The example uses genuine data from the levels 1 - 3 group combined. Overall there is a clear trend towards 'merit' grades. There is also a significant decrease in 'pass' grades as we move from activists to reflectors, and a decrease in 'distinctions' as we move from the pragmatist learners through to the activists. Once data for each of the four learning styles was plotted, this approach provided a good basis for comparison and further analysis.

Next I wanted to compare the results for each learning style group to the results for the overall sample as this would enable me to identify any large differences between learners who adopt a particular style, and those achieved by the sample as a whole. To achieve this I began by grouping all learners at levels 1 - 3 under their individual learning style, and carrying out chi-squared tests to ascertain the probability of each set of results occurring by chance. Any sets of results that were unlikely to have occurred by chance would become the focus during the next phase of the study when the results were analysed further. Having carried out the tests on levels 1 - 3 combined, I then focused on each of the levels in turn. Again, any results with a probability rating that suggested that they could not have occurred by chance would be subject to further scrutiny as the study progressed.

Next, my focus switched to individual assessment instruments. My main interest in this area of research was to ascertain whether certain types of learner perform better on specific types of assessment. My methodology again involved a combination of statistical, graphical and qualitative techniques largely in line with those discussed above, and the percentages of each grade attained were plotted in an attempt to identify any differences or patterns for further research.



The graph shows a changing trend as we look at each of the four learning styles. Activists have clearly gained more passes and less merits and distinctions than other types of learner. They have also recorded more fail grades. Reflectors are arguably the most successful learners on the five assessments under analysis with a large percentage of merits and distinctions and very few fail grades. Many other trends can also be identified from the graph.

Figure 3.4

Finally, I turned my attention to the ‘hub learners’. Out of my sample of 100 learners just 6 fell into this category with just 1 example of an ‘origin learner’ (i.e. a modulus and argument of ‘0’). These learners were analysed as a sub-group as they were outside the range for any of the levels used in the study so far. My hypothesis was that these learners would be very adaptable, and should perform reasonably well across the range of assessment instruments. My first task was to re-analyse their LSQ’s to check the validity of the scores as to take two extreme situations, ticking every question on the LSQ would lead to a zero score overall, as would not ticking any. Once I was happy that the LSQ scores were valid, I then carried out a precise analysis of these 6 individuals using both quantitative and qualitative techniques for this purpose.

Strand 5 – Perspectives on Knowledge and it’s Relationship with Performance during BTEC (NC) Assessment.

The final strand of my research concerns knowledge and assessment and my objective in the first instance was to carry out further analysis of the five assessment instruments used above, in an attempt to identify the different types of knowledge that are being tested in each case. I then went back to the results of my research in the previous section which mapped individual learning styles to assessment performance on the five instruments, and attempted to establish whether particular types of learner perform better on assessments which bias certain types of knowledge.

Initially I adopted a combination of qualitative and quantitative techniques in an attempt to establish which types of knowledge the five assessment papers under investigation are testing. My analysis was based upon the definitions of knowledge types provided by Hiebert (1986), and this led to a search for four categories of knowledge which are listed below:

Level ‘a’ Conceptual Knowledge (Context specific).

Level ‘b’ Conceptual Knowledge (Non-context specific).

Level ‘a’ Procedural Knowledge (Symbolic algorithms)

Level ‘b’ Procedural Knowledge (Rules & procedures)

To help this area of research to progress, I designed a systematic approach to identifying and recording the different types of knowledge that were assessed by each

of the papers. This included detailed criterion for identifying the different knowledge types listed above and is included as appendix (L) at the rear of this report. The criteria used are based largely on the work of Hiebert (1986). This combination of qualitative and quantitative approaches, in my opinion, led to a successful methodology for this area of analysis. Qualitative techniques were employed initially to analyse documentary evidence and the results of this analysis were then recorded and converted to percentages to establish the balance between the four knowledge types. The graphical representations that are included as appendix (M & N) give a clear indication of bias on each of the papers and provide an overall picture of bias across the five assessments.

Once I had completed my analysis of knowledge types, I then looked for relationships between individual learning styles and apparent success or failure on papers that biased certain types of knowledge. This involved a qualitative analysis of evidence from the previous strand of research and the analysis outlined above. Any significant relationships were plotted graphically, and though these findings were not conclusive, they do provide scope for further research.

Chapter 4: Findings.

What is the Nature of Assessment on BTEC (NC) Courses in Engineering Principles?

For the purpose of this research, I focused upon the four BTEC (NC) academic modules that are taught within the 'Principles and Advanced Training Squadron' (PATs), at RAF Cosford. The four modules are listed below:

- 1. MATHEMATICS.**
- 2. MATERIALS SCIENCE.**
- 3. ENGINEERING SCIENCE.**
- 4. ELECTRICAL PRINCIPLES.**

What are the essential characteristics of the assessment scheme on BTEC (NC) academic modules at RAF Cosford?

How do the Different Assessment Procedures Interrelate to Form a Coherent Assessment Scheme?

Analysis of documentary evidence collected across the 4 subject modules revealed a complex system of procedures that linked together to form what could be loosely described as a 'dendritic'⁶ model of assessment. It was apparent from the documentary evidence collected that there are many similarities in terms of assessment across the 4 subject areas, with exams and assignments forming the backbone of the overall strategy, supported by a number of techniques from RAF, BTEC and individual sources, each of which serves a different purpose within the teaching/learning process. A detailed analysis of each assessment technique will follow in a later stage of this report, it seems an appropriate starting point, however, to first establish precisely what the relationship is between each strand of the assessment strategy in the areas identified, and to try and establish an overall picture of how BTEC students are assessed as they progress through each module. The starting point for my analysis of these issues was the documentary evidence that I had collected across the 4 subject

⁶ The term 'dendritic' in this context means 'tree-like', with branches and sub-branches.

areas. A detailed list of these items is included as appendix (O) at the rear of this report.

If I may begin with the BTEC (NC) mathematics module, my initial approach was to set out the collected evidence in progressive order and try to establish interrelationships between the different assessment procedures that make up the package. The obvious starting point for this procedure was the pre-technician diagnostic test which students sat during the first two periods of the module. It should be noted, that all students have already undertaken a 'Lead in Further Training' package, which includes 36 periods of basic numeracy, prior to starting the BTEC (NC) module. By working from this basic starting point and talking informally to staff and students as work progressed, I was able to build up a full picture of the assessment strategy that supports the mathematics module, and to place each procedure into its strategic position within the system. The end result of this exercise was a diagrammatic interpretation of my findings, which is included as figure 4.1 overleaf.

What we have is a complex mix of formative and summative techniques, which remind us of Harris & Bell's 'Bi-Polar Constructs' and alert us to many of the points that were discussed when those issues were reviewed. An interesting feature of the assessment scheme relates to the product/process debate that was outlined within my literature review and appeared in an earlier part of this report. Analysis of figure 4.1 reveals very few formal procedures where product objectives are being tested other than the mid and end phase exams. Techniques for testing process objectives are clearly in the majority with the assessment of common skills prominent and continuous within the strategy. So how are common skills assessed in this context? BTEC define common skills as being:

"Transferable skills which play an essential role in developing personal effectiveness for adult and working life, and in the application of specific vocational skills"

(BTEC 1992 Page 2)

BTEC (NC) ASSESSMENT STRATEGY FOR MATHEMATICS.

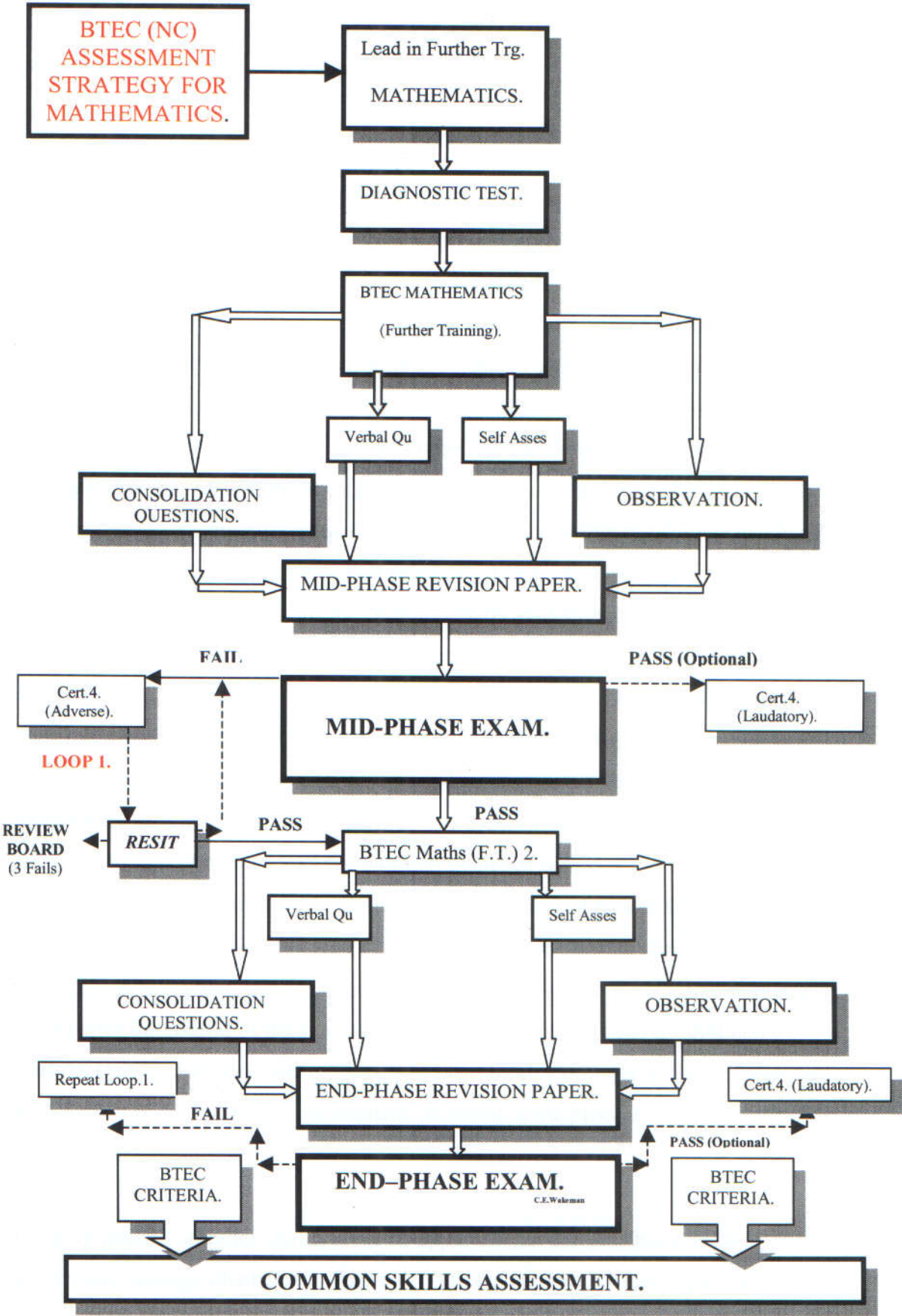


Figure 4.1

You will recall that BTEC/EDEXCEL provide seven distinct outcomes for the assessment and reporting of common skills, and from these emanate performance criteria and range statements to assist in the assessment process. (See appendix (A) for examples).

For the purposes of this investigation, I focused my attention on a 'common skills logbook' and 'trainee handbook', both of which are given to students at the outset of their studies. Though I do not wish to get involved in a validation exercise at this stage of my report (validity is addressed in subsequent sections), it is clear from the common skills logbook, that it is structured around the 18 outcomes identified by BTEC/EDEXCEL within their general guidelines (1992), and which were discussed within my literature review earlier in this report. It should be noted that each of the 18 outcomes fall into one of the seven common skill areas that are standard for BTEC (NC) courses in engineering principles. Guidance notes within the 'trainee handbook' that is given to each student on arrival at the No. 1 School of Technical Training (RAF Cosford), outline the purpose of the common skills assessment and provide instructions to the trainee on how to 'claim' common skills as they progress through the BTEC (NC) modules. It also provides the performance criteria that the student must meet in order to achieve each outcome (see appendix (P)), and there is a short note on 'context' that gives examples of valid assessment opportunities, which the trainee may exploit. At the end of their course each trainee should have a completed common skills logbook with all the required evidence signed off as they progress through the various modules. The completed document is then submitted for assessment and if deemed satisfactory, has a value of one unit towards the BTEC (NC). It seems evident, that the approach to common skills at RAF Cosford is largely in line with the second of the five models for common skills delivery outlined by Cashian (1995), and reviewed on page 9 of this report. Common skills are integrated within most of the modules with students involved in the process of developing and monitoring their collection.

Looking beyond common skills, it seems apparent that the 'backbone' of the assessment strategy identified in figure 4.1, are the summative techniques, which along with common skills contribute to the students final grade - namely, the mid and end phase examinations. Figure 4.1, illustrates the system which supports these

examinations regarding students who fail and need to re-sit, and it seems appropriate at this point to add a written commentary for that particular part of the diagram (Loop 1), as it requires further explanation.

Loop (1), shows the path a student must follow if he fails an examination. It is identical for both examinations and also transcends subject boundaries, as it may be applied in all areas where examinations or assignments form part of the assessment procedure. Consider the mid - phase exam. A student who passes moves on to F.T. maths (2), this represents the second half of the maths course. It is also evident from the diagram that tutors may submit a 'laudatory' cert.4. (See appendix (Q)), if a student has performed particularly well. This is an RAF document that is filed on the students record for future reference. If a student fails they follow loop (1). In this case the 'adverse' cert.4. is mandatory and leads to an interview with a senior lecturer to determine the reason for the failure. If the interview is satisfactory, the student will be allowed to re-sit a different exam paper, and if successful, will continue to F.T.maths (2) as indicated on the diagram. If the student fails the re-sit they will continue around loop (1) a second time. A second re-sit failure meaning three fails in all, will result in the case being referred to a review board consisting of various personnel who have been involved with the student during the course, and chaired by a high ranking officer. Other than in exceptional circumstances, this almost inevitably leads to the student being re-coursed (i.e. made to start the module again), or, if the student is deemed unsuitable they may cease training and be returned to their unit.

The remaining assessment procedures illustrated by the diagram are formative by nature and vary in their degree of formality. The *diagnostic test* is possibly one of the more formal procedures and is used by staff, and students, to assess their prior knowledge and determine a starting point for instruction. Marks from this source are not formally recorded or used for any summative purposes. *Consolidation questions* and *revision papers* also serve a formative purpose, and although tutors do take an interest in the work that is generated through these procedures, they are primarily for the students benefit and form a self-assessment tool for use at appropriate points in the course. Again no marks from this source are formally recorded. On an informal basis, *verbal questioning* and *observation* are also in evidence, being used by tutors to aid the process of teaching and learning. Though informal by nature, it is acknowledged

that evidence from these sources may be used as a basis for report writing during the course, or for verbal reporting at review boards where appropriate.

If we consider the other subject areas that are under investigation, a similar pattern emerges. The only significant difference is the inclusion of laboratory work and written assignments within each of the three modules, the purpose of which is to provide marks for summative purposes and, along with examination score, is used to determine a students final grade. The engineering science assessment strategy that is included as figure 4.2 overleaf, shows how the assignment fits into the overall structure. This provides opportunities for students to experiment with some of the equipment available in the laboratory, and culminates in a scientific report that is tutor marked in accordance with written criteria. It also provides opportunities for common skills to be assessed as outlined earlier in this report. The two remaining assessment strategies for materials science and electrical principles are included as appendices (R) and (S) at the rear of this report.

To conclude this section of my report, it remains to evaluate the assessment techniques that make up the four assessment strategies in relation to Harris & Bells bi-polar constructs, which were reviewed on page 5 of this report. Table 4.1 that is included on page 87 provides a starting point for this process.

Reference to Table 4.1 alerts us to some interesting points that may be of relevance during our evaluation of construct validity in the following section of this report. It is apparent from the table that none of the assessment procedures used on the BTEC (NC) courses are 'norm referenced'. 'Criterion referencing' forms the basic construct of many instruments in use, and I feel sure that even for informal techniques such as verbal questioning and observation, tutors have their own mental criteria for assessing students. My concern is that many instruments only provide 'assessment criteria' with no means of grading performance beyond pass level. This may lead to students capable of performing above pass level not having the opportunity to display their full potential and may have implications for student motivation. I include some recommendations on this issue in the closing sections of this report.

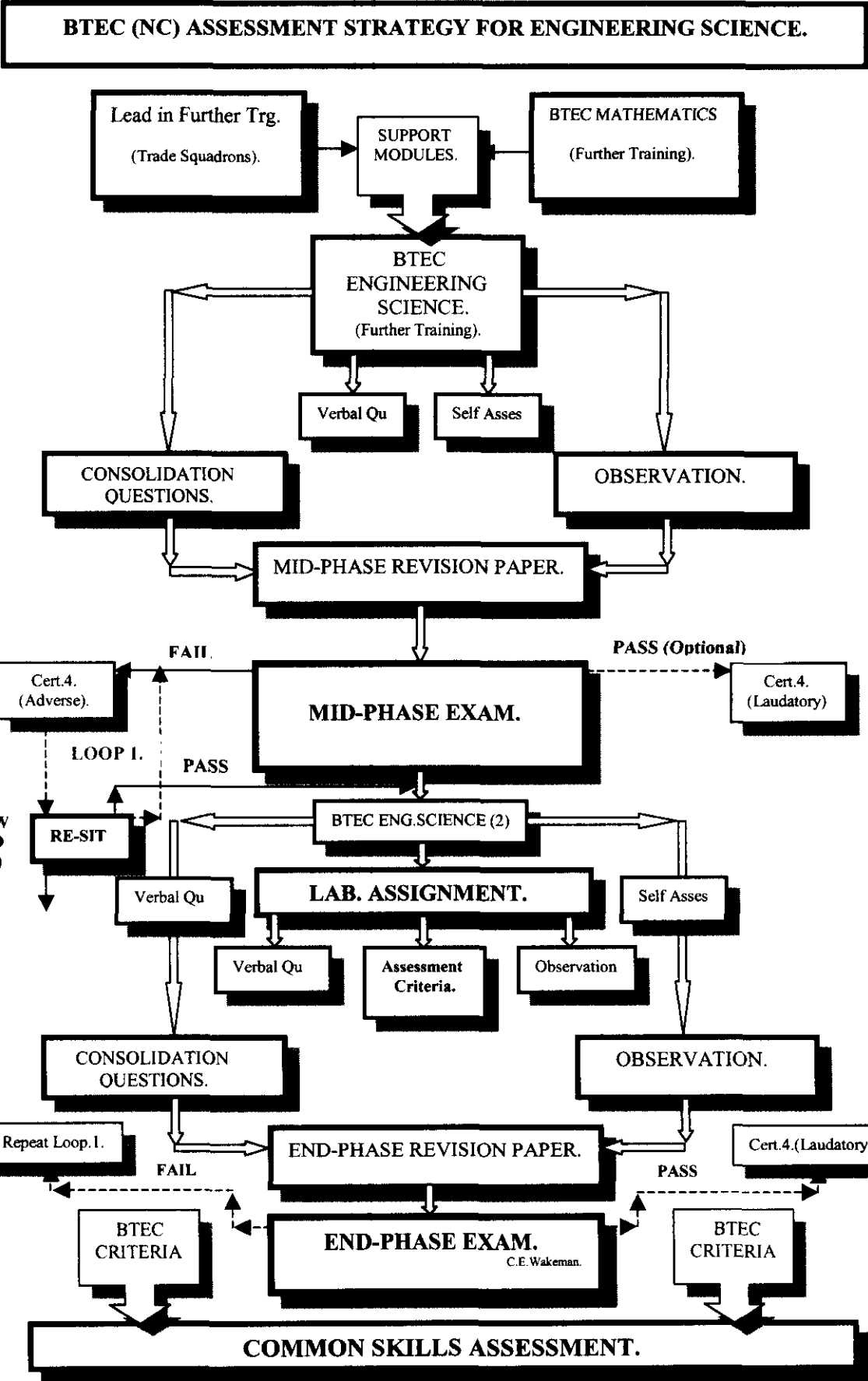


Figure 4.2

BTEC (NC) Assessment	Informal	Semi-Formal	Formal	Formative	Summative	Process	Product	Criterion Ref.	Norm.Ref.	Individual Focus	Group Focus	Continuous	End Point	Learner Judged	Tutor Judged	Internal	Int.Set/Ext.Ver.	External
DIAGNOSTIC TEST.		X		X			X	X		X				X		X		
VERBAL QUESTIONING	X			X		X	X			X		X			X			
SELF ASSESSMENT	X			X		X	X			X		X		X				
CONSOLIDATION QUESTIONS		X		X			X	X		X		X		X	X			
LABORATORY ASSIGNMENTS			X		X	X	X	X			X		X		X		X	
OBSERVATION	X			X		X				X		X			X			
REVISION PAPERS		X		X			X	X		X			X	X	X			
EXAMINATIONS			X		X		X	X			X		X		X		X	
BTEC COMMON SKILLS			X		X	X	X	X			X	X			X		X	

Summary of BTEC (NC) assessment constructs.

Table 4.1

With the exception of examinations and assignments that are clearly summative techniques, formative procedures are clearly in the majority and with the balance leaning towards formative procedures, it necessarily follows that many of the techniques in use are continuous as opposed to end point. Furthermore, all procedures, with the exception of the three summative elements have an individual focus, in other words, they are based upon the needs of individual students rather than tending towards a standard that has been set by a large group of students. Finally, as noted in an earlier section of this report, BTEC have placed great emphasis on process in recent years and this is also reflected by our findings here. Process is formally assessed through assignments and BTEC common skills, but also comes under scrutiny on a continuous basis through verbal questioning and observation, and indeed, through student self-assessment.

Strand 2 – The Validity of the BTEC (NC) Assessment Scheme in terms of ‘Construct’ and ‘Content’.

The authors of the E819 study guide (OU 1990 Page 92), suggest that assessment validity is concerned with the extent to which the sample of behaviour in the assessment represents the universe of that behaviour and how well defined that universe is. This statement appears to implicate several forms of validity, of which 'content' validity is certainly one. It also alludes to 'construct' validity, as a distinction may be made between the range of assessment tasks that the students undertake, and the extent to which the universe of behaviours being tested is affected as a result. As we have already seen, the range of assessment techniques which comprise the BTEC (NC) assessment strategy are wide and varied. They form into what I have described as a 'dendritic' system of assessment that has its roots in common skills, a stem or backbone of examinations and assignments, and numerous branches of assessment procedures that range from observation and verbal questioning to the more formal revision and consolidation exercises. For the purposes of this investigation, we shall begin by focusing upon 'construct validity', a concept which seems fundamental to any assessment package, if we are to retain confidence in our judgements about students.

Does the Assessment Strategy for the BTEC (NC) Academic Units have ‘Construct Validity’?

Testing for 'construct validity' is a challenging task, as it is a concept that is irrevocably linked to many factors that require deep and detailed analysis of their own. Learning domains and taxonomies, or knowledge structures are examples of the type of factors we must consider, and later in this research I shall investigate individual learning styles and their likely impact on construct, and other forms of validity. It is a notion that is also strongly linked to the 'purpose' of the assessment and the way the information generated will be used. For grading and certification a summative, end point construct is common for example, and for the purposes of aiding teaching and learning formative continuous constructs would seem appropriate. Consequently, the evaluation of construct validity that follows will not account for all the factors which impact on this issue. Even so, it will present a starting point and hopefully sow the seeds for further discussion and development in subsequent stages of this study.

So how are we to begin in our quest to evaluate what is clearly an intricate and often elusive concept? As we have based our analysis of the essential characteristics of BTEC (NC) assessment upon Harris & Bells bi-polar constructs, it would seem appropriate to also use these as a basis for evaluating the construct validity of the scheme that is under investigation. My starting point, is to attempt to build up a picture of which assessment methods would be appropriate in particular circumstances, and then to map across to the BTEC strategy to determine whether correlation exists and to pinpoint where there are anomalies. Table 4.2 overleaf, which is partly based upon the work of Reece & Walker (1995 page 362), suggests a number of possible assessment ideals. A number of sources have been used in the table design, including material from the Royal Air Force School of Education which is based at RAF Newton and the Training Development Support Unit. Methods printed in *italics* represent the methods that are employed on the BTEC (NC) academic modules at RAF Cosford. These can be located on figures 4.1 and 4.2, which outline the essential characteristics of assessment and were included earlier in this report. They are also evident on the flow diagrams for the materials science and electrical principles assessment strategies that appear as appendix items (R) and (S) at the rear of this report.

Though the table is useful as a starting point for evaluating 'construct validity', it should be acknowledged that such a schedule does not represent a conclusive relationship between assessment purpose and the methods that should be employed. Each learning experience consists of a unique and complex interaction that makes such attempts in themselves invalid and should only be adopted at surface level. Even so, it does have some value here. If nothing else it shows a considerable degree of correlation between what are acknowledged as suitable methods of assessment for the purposes shown and those used in the context under investigation. Against this criteria construct validity on BTEC (NC) assessment at RAF Cosford appears to be quite good.

ASSESSMENT METHOD IDEALS.

ASSESSMENT TECHNIQUES USED ON BTEC (NC) ACADEMIC MODULES SHOWN IN *ITALICS*.

ASSESSMENT PURPOSE.	TO AID THE PROCESS OF TEACHING/LEARNING.	FOR GRADING AND CERTIFICATION.
	<i>Constructs:-Semi/Informal, Formative, Process, Product, Crit.Ref, Ind.Focus, Continuous, Learner/Tutor Judged.</i>	<i>Constructs:-Formal, Summative, Product, Process, Crit.Ref, Group Focus, End Point, Tutor Judged, Internal Set/External Verified.</i>
TO ASSESS PRIOR LEARNING.	<i>PRE-COURSE TEST. INTERVIEW. OBSERVATION – (Psychomotor Skills)</i>	
TO DIAGNOSE LEARNING NEEDS AT THE OUTSET OF A MODULE.	<i>DIAGNOSTIC TEST. INTERVIEW. OBSERVATION.</i>	
TO ASSESS LOWER LEVEL COGNITIVE OBJECTIVES.	<i>MULTIPLE CHOICE QUESTIONS. MATCHING BLOCK QUESTIONS. SHORT ANSWER QUESTIONS. COMPLETION QUESTIONS.</i>	<i>MULTIPLE CHOICE TEST. MATCHING BLOCK TEST. SHORT ANSWER TEST. COMPLETION TEST.</i>
TO ASSESS HIGHER LEVEL COGNITIVE OBJECTIVES.	<i>CONSOLIDATION QUESTIONS. REVISION PAPERS. STRUCTURED/EXTENDED ESSAY. VERBAL QUESTIONING.</i>	<i>EXAMINATION. ASSIGNMENT. VERBAL QUESTIONING.</i>
TO ASSESS PSYCHOMOTOR SKILLS AND OBJECTIVES.	<i>SKILL TEST OBSERVATION. ASSIGNMENT. SELF ASSESSMENT. PRACTICAL PHASE TEST.</i>	<i>SKILL TEST OBSERVATION. ASSIGNMENT. PRACTICAL PHASE TEST.</i>
TO ASSESS AFFECTIVE OBJECTIVES.	<i>TUTORIAL. OBSERVATION. 3rdPARTY EVIDENCE.</i>	<i>TUTORIAL. OBSERVATION. 3rdPARTY EVIDENCE.</i>
TO ASSESS PERSONAL EFFECTIVENESS.	<i>OBSERVATION. PEER ASSESSMENT. TUTORIAL.</i>	<i>OBSERVATION. TUTORIAL.</i>
TO PREDICT SUCCESS ON SUBSEQUENT MODULES.	<i>VERBAL QUESTIONING. OBSERVATION.</i>	<i>EXAMINATION. ASSIGNMENT.</i>
TO ASSESS COMMON SKILLS.	<i>3rdPARTY EVIDENCE. OBSERVATION. INTERVIEW. ASSIGNMENT.</i>	<i>3rdPARTY EVIDENCE. OBSERVATION. INTERVIEW. ASSIGNMENT.</i>

Adapted from Reece & Walker (1995) Page 362.

Table 4.2

If we are to achieve a more credible evaluation, we must delve deeper. I have selected some typical questions at random from the instruments under investigation. Consider the questions below, one from section (a) and one from section (b) of a typical mathematics mid-phase examination:

Section (a):

Find the value of 'x' in the following equation:

$\text{Log}_3 8 = (x + 1)$

5 marks.

Obj: 1.2.19

Section (b):

The table below gives details of how a car decelerates from 4m/s to rest in 6 seconds. Using this information:

a) Plot a graph of deceleration (y axis) against time (x axis).

(10 marks)

Obj: 1.8.3

b) Calculate, using the trapezoidal rule, the area under the graph.

(10 marks)

Obj: 1.7.1

t (secs)	0	1	2	3	4	5	6
Deceleration m/s	4	3.8	3.4	2.8	2.2	1.4	0

What are we testing here? If we take the section (a) question it is listed as testing objective 1.2.19. This is an enabling objective that is stated in the instructional specification as follows:

"Solve indicial equations where the indices are linear in one unknown"

(BTEC Mathematics (N14166H)

At surface level there doesn't appear to be a problem, what we have in the section (a) question is a linear indicial equation with one unknown but, lets have a look at a possible solution:

1. Firstly, we have to re-arrange the equation and convert the simple indicial relationship into a logarithmic relationship.

$$\text{Log}_3 8 = (x + 1) \quad \therefore \quad 3^{(x+1)} = 8$$

Therefore: $(x + 1)\text{Log } 3 = \text{Log } 8$

This operation is in line with EO 1.2.12 which states:-

"Convert a simple indicial relationship into a logarithmic relationship and vice versa."

2. We now have to re-arrange the new equation to make 'x' the subject:

$$x \text{Log } 3 + \text{Log } 3 = \text{Log } 8 \quad \text{Therefore: } x \text{Log } 3 = \text{Log } 8 - \text{Log } 3$$

$$\text{Therefore: } x = \frac{\text{Log}8 - \text{Log}3}{\text{Log}3}$$

This operation is in line with EO 1.5.2 which states:-

"Transpose formulae in which the subject appears only once, where symbols are connected by one or a combination of the following arithmetic operations:

- (a) Addition.
- (b) Subtraction.
- (c) Multiplication.
- (d) Division."

3. Still we must find the value of 'x'. This would normally be done with the aid of an electronic calculator:-

$$x = \frac{\text{Log}8 - \text{Log}3}{\text{Log}3} = 0.892 \text{ to 3dp.}$$

This is in line with EO 1.1.4 which states:-

"Use a scientific calculator to find the values of exponential, logarithmic and degree/radian functions."

Finally, we must substitute the value found back into the equation to check that our answer is correct:-

$$3^{(0.892 + 1)} = 8$$

This is in line with two EOs - 1.1.2 and 1.5.6. They state:

"Use a scientific calculator to extend operations to include reciprocals, roots, powers and pi."

(1.1.2)

"Solve engineering problems given a formulae and check answers by numerical substitution."

(1.5.6)

We may now re-assess the construct validity of this question. It is included in a summative examination to test a high level cognitive objective. That seems acceptable. It is listed on the paper as testing objective 1.2.19. Well, that is acceptable too, but as we have seen, it also tests five other objectives as the student progresses through the question. Construct validity asks the question, does the test measure what it purports to measure? In the case of this question, we could say, well it does, but it measures five other things as well, and you may argue that if the student was weak on any of the other objectives where competence was required, then they would fail to arrive at the correct answer to the problem set. This is where the marking scheme becomes important, but even withstanding that, construct validity has undoubtedly been weakened through poor question design if we return to our original definition.

Moving on to the section (b) question, the author of the paper suggests that this question tests two objectives - 1.8.3 which states:

"Plot co-ordinates on a pair of labelled Cartesian axes"

and; 1.7.1 which states:-

"Use numerical methods of integration to solve problems relating to volume and surface area."

There is little doubt that these objectives are tested by this question. Nonetheless, lets look at a possible solution:

1. Firstly, in part (a) of the question, we are asked to plot a graph of deceleration against time. The table of values is provided for this purpose.

t (secs)	0	1	2	3	4	5	6
Deceleration m/s	4	3.8	3.4	2.8	2.2	1.4	0

The graph is included as figure 4.3 overleaf.

In plotting the graph it is my view that the following objectives are being tested in addition to 1.8.3 which is stated above:

"Define and label a set of Cartesian axes"

(Obj: 1.8.1)

"Determine scales from given data and mark axes accordingly.

(Obj: 1.8.2)

So in this case, in addition to objective 1.8.3 which the author specifies, two further objectives are being tested within part (a) of the question. In part (b), we are asked to use the trapezoidal rule to calculate the area under the graph. This clearly fits in with objective 1.7.1 which is specified for that part of the question, but to see whether this is the only objective being tested we must again analyse the answer which is included on figure 4.3.

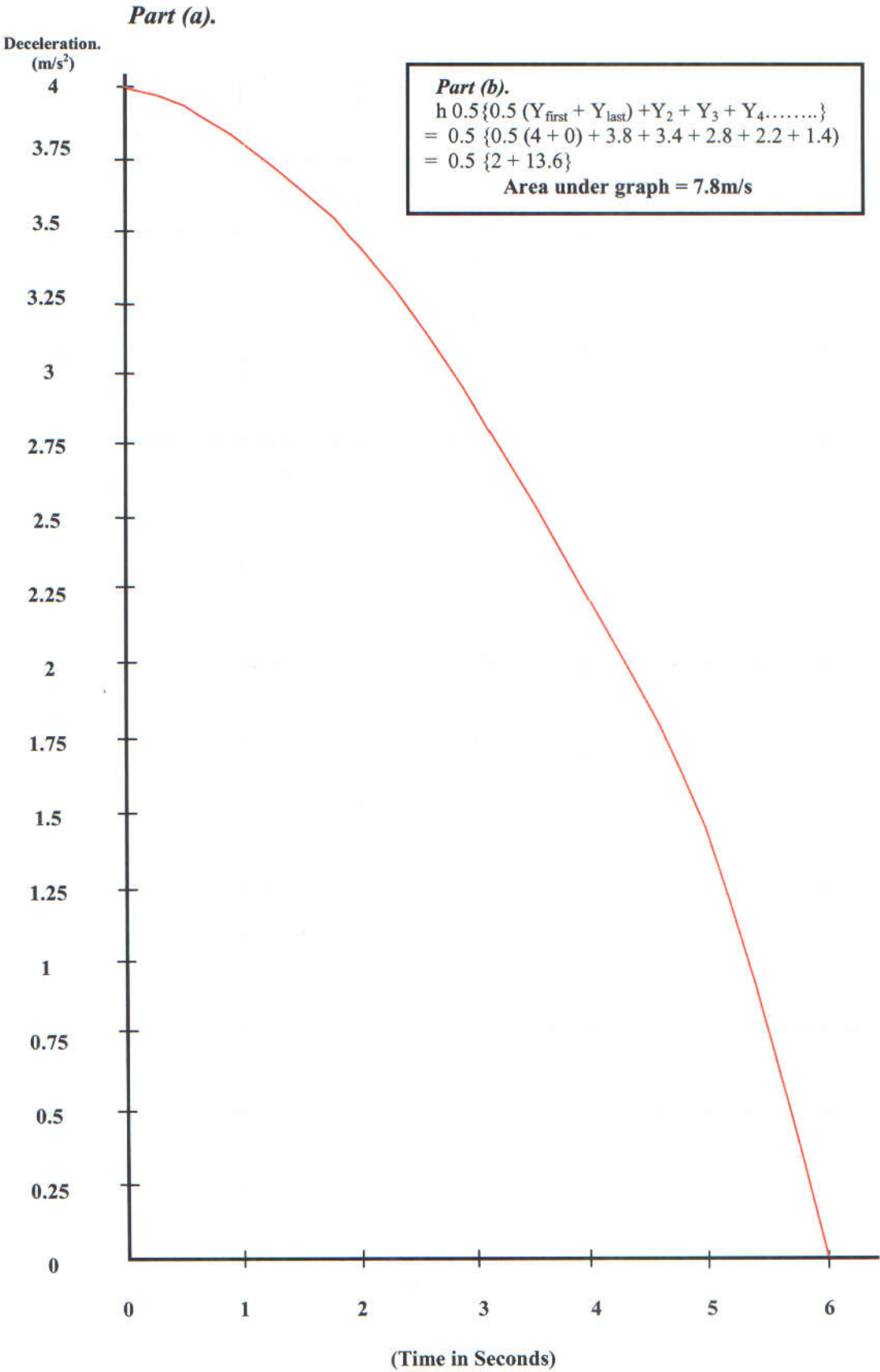


Figure 4.3

So which additional objectives are being tested here? I would suggest that the following two are clearly implicated in reaching the final solution:-

"Solve engineering problems given a formula and check answers by numerical substitution."

(Obj: 1.5.6)

"Use a scientific calculator to revise use of the four basic arithmetic operations and make use of memory facility."

(Obj: 1.1.1)

This question, therefore, tests a minimum of six objectives⁷ rather than the two specified. As in the previous case, construct validity has been weakened by poor question design and one may argue that content validity is also affected, since statistically, marks have been allocated to two objectives, whereas six are actually tested. What this means, is that any work done with the statistics resulting from this test become meaningless and in themselves invalid.

It is not possible within this research to analyse all questions in this way, nor would it be of any benefit as the point has already been made by the above examples - poor question design has undoubtedly weakened construct validity. What is appropriate at this stage is to turn our attention to 'content validity' and try to establish whether the objectives being tested adequately sample the learning situation. Again, the large quantity of assessment instruments which make up the BTEC (NC) assessment strategy make it virtually impossible to test all of them. Consequently, a sampling procedure must be employed which gives us the best possible chance of achieving a good cross section of the instruments in use, and ensures that as many of the different types of instrument as possible are included in the analysis. To this end, I employed a procedure which Wragg (1987) calls "Stratified Random Sampling" and which I outlined in the methodology section earlier in this report. The instruments selected using this technique are listed below:

⁷ Two mathematicians within the Principles and Advanced Training Squadron at RAF Cosford have validated my judgement regarding the objectives tested by the questions under analysis.

PRE-TECHNICIAN MATHEMATICS TEST.

MATHS MID-PHASE CONSOLIDATION PAPER.

MATHS END-PHASE CONSOLIDATION PAPER.

MATHS MID-PHASE EXAMINATION (Version J).

MATHS END-PHASE EXAMINATION (Version M).

**ENGINEERING SCIENCE CIRCULAR MOTION
LOCAL TRADE TRAINING NOTES & POST TESTS.**

MATERIALS SCIENCE END-PHASE EXAMINATION.

ELECTRICAL PRINCIPLES AC. REVISION PAPER.

Do the Instruments which make up the Scheme have 'Content Validity'?

Having selected the above sample, analysis of content validity took place on three levels. The questions which follow form the basis of this part of the analysis and have evolved from points raised by Reece & Walker (1995) and Dawson & Thomas (1972), each of which were reviewed earlier in this report. Firstly, it seemed an appropriate starting point to ask - do the questions and tasks included in the above instruments map to objectives in the syllabus? Secondly, where appropriate, is the weighting correct between the time allocated to various topics in the syllabus and marks allocated to those same topics during assessment? These issues arise from points discussed by Reece & Walker (1995 pages 363 - 367), and the weighting issue seems particularly important where summative tests are concerned. Finally, are there any other obvious factors affecting 'content validity' which we need to consider? This question leaves scope for investigating some of the issues raised by Dawson & Thomas (1972) concerning the implications of 'choice' etc. during summative tests.

My general approach to this area of research involves statistical techniques followed by qualitative analysis of the data. Consider the nomograph which is published as figure 4.4 overleaf. It should be evident from the information on the graph that each question which is included on the assessment instrument which is under evaluation is being mapped to a training objective (TO) from the syllabus. The TOs to be studied by each trade are determined by the trade sponsor who takes account of BTEC and work related requirements. For the sake of clarity, the question number is included on the left hand scale, the training objective number taken directly from the syllabus is on the right hand scale, and the training objectives (TOs) to which each number relates are included at the bottom of the graph under the title 'key to training objectives'. At this stage it is simply a case of mapping each question to its corresponding TO with a view to finding any objectives that are not tested at all, and indeed, any rogue questions that fail to test any of the objectives listed. All TOs should be tested during assessment but not all enabling objectives (EOs). EOs are subject to sampling.

Figure 4.4 relates to the pre-technician mathematics test, that is taken by all students at the outset of the BTEC mathematics module. At this stage in the course all students have already completed the 'lead in to further training' maths course which comprises basic numeracy and other fundamental elements some of which are extended during the BTEC phase. The pre-technician test is based upon the training objectives, which comprise the lead in to further training course. It is a formative test that is designed to give teaching staff a starting point for instruction and to provide an icebreaker at the beginning of the course. Informal interviews with staff suggest that many of them use the test itself as a teaching resource by carefully going over all the answers and exploring different methodologies. The test under analysis here, is one of three that are available for use.

Analysis of figure 4.4 suggests that this particular test is not very strong in terms of content validity. Of the ten questions included on the paper, five do not test any of the objectives which we would expect to be tested, and the remaining five questions all test the same training objective (2.7), which relates to algebraic equations. There are, therefore, nine objectives in which the student should now be competent, and which are pre-requisites for the BTEC maths phase, which are not tested at all.

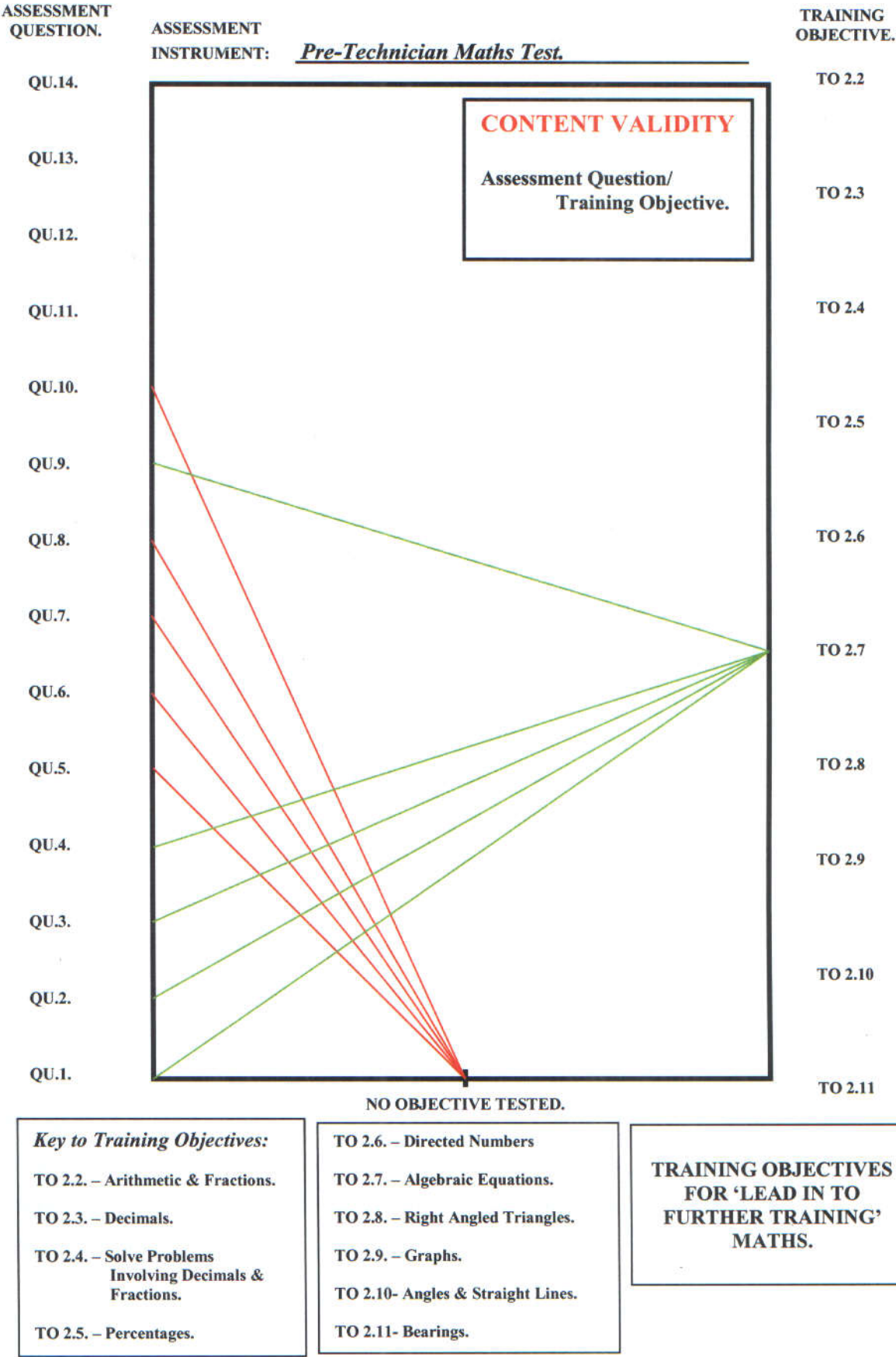
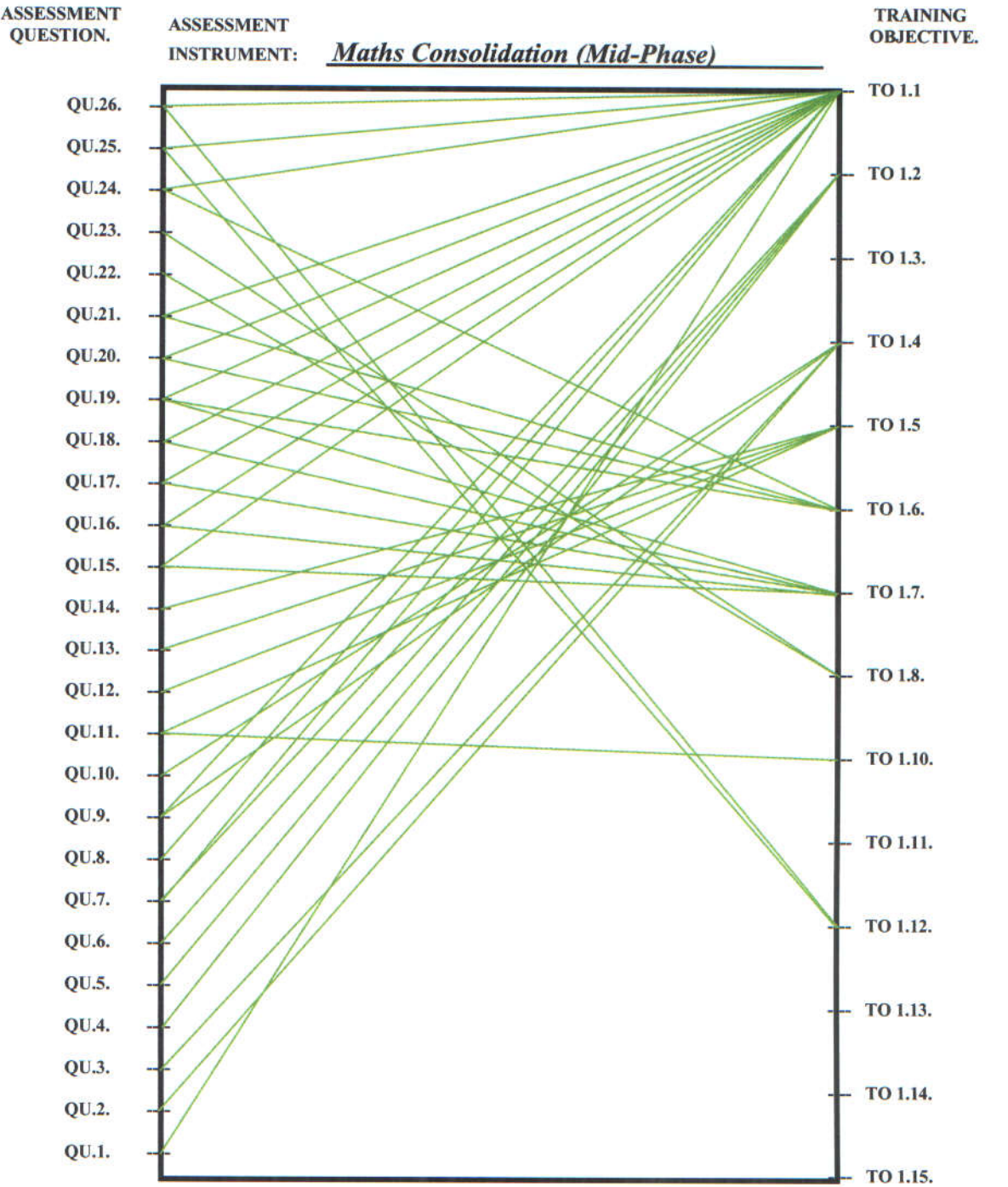


Figure 4.4

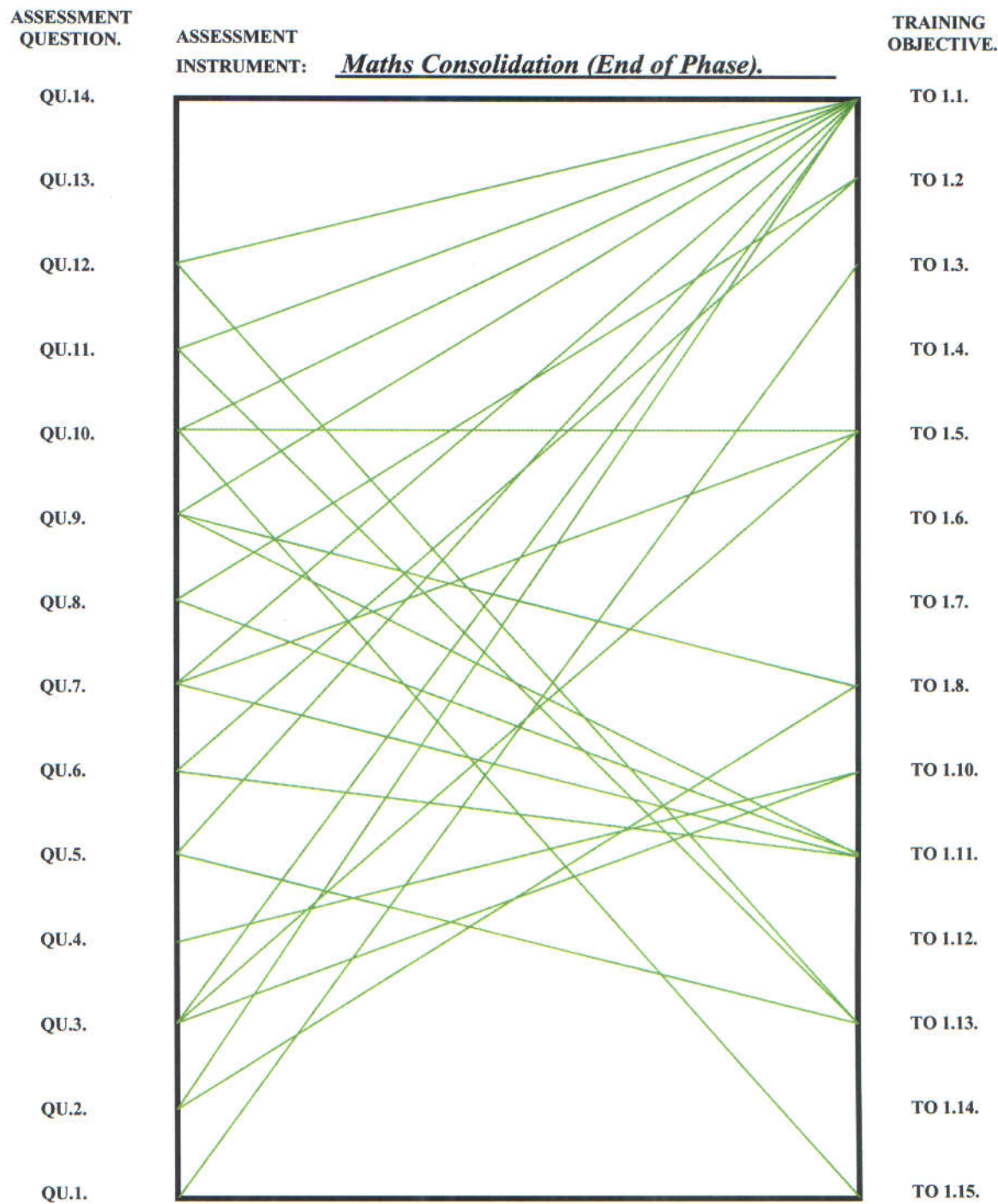
Further qualitative analysis reveals that the five questions which fail to test a relevant objective actually relate to objectives from the module that the students are about to begin. This seems a very peculiar way of beginning a module by testing students on work they haven't yet covered. I would suggest that this could be very de-motivating for students just at the time when interest and motivation should be at a maximum. If we are to equate this test to its purpose, therefore, I would be inclined to conclude that it is very weak in terms of content validity and requires urgent revision. One interesting point to note is that the test does appear to have construct validity. The assessment instrument itself seems suitable for the purpose it was designed, and its theoretical basis seems sound. It appears that an assessment procedure can be strong in some aspects of validity while weak in others, though it is the validity overall that remains important and this fact should not be overlooked.

Moving on to the mathematics consolidation papers, it seems appropriate to look at these as a pair as each serves the same purpose as far as the assessment strategy is concerned, and with one being a mid course paper, and the other an end course test, it necessarily follows that between them they should cover all the TOs that appear in the syllabus. The nomographs for these two instruments are included as figure 4.5 and figure 4.6 overleaf. If we begin with the mid-phase paper, it is apparent immediately, that none of the twenty six questions included on the paper fail to test an objective at all. Weighting is again irrelevant as this is a formative assessment tool with no marks allocated and none recorded. Its purpose, is to aid the process of teaching and learning and to that end it has an individual focus. The task of analysing the graph is made difficult by the fact that the TOs are not taught in the order they appear in the syllabus. TO 1.12 (Trigonometry) for example, is taught during the early stages of the course and appears in the mid-phase, and TO 1.3 (Tables & Charts) which one would expect to be in the mid-phase actually appears in the end-phase test as it is taught late in the course. A breakdown of the TOs taught in each phase is included as table 4.3, on page 104 of this report:



Key to Training Objectives:		
TO 1.1. – Electronic Aids.	TO 1.5. – Formulae & Substitution.	TO 1.11. – Calculus
TO 1.2 – Decimals, Percentages, Indices & Logarithms.	TO 1.6. – Areas, Perimeters & Mass.	TO 1.12. – Trigonometry.
TO 1.3 - Tables & Charts.	TO 1.7. – Surface Area & Volume.	TO 1.13. – Vectors.
TO 1.4 – Numbering & Measuring Systems.	TO 1.8. – Graphs & Linear Laws.	TO 1.14. – Complex Numbers.
	TO 1.10. – Linear, Quadratic & Simultaneous Eqn's.	TO 1.15. – Statistics.

Figure 4.5



Key to Training Objectives:

TO 1.1. – Electronic Aids.

TO 1.2 – Decimals, Percentages, Indices & Logarithms.

TO 1.3 - Tables & Charts.

TO 1.4 – Numbering & Measuring Systems.

TO 1.5. – Formulae & Substitution.

TO 1.6. – Areas, Perimeters & Mass.

TO 1.7. – Surface Area & Volume.

TO 1.8. – Graphs & Linear Laws.

TO 1.10. – Linear, Quadratic & Simultaneous Eqn's.

TO 1.11. – Calculus

TO 1.12. – Trigonometry.

TO 1.13. – Vectors.

TO 1.14. – Complex Numbers.

TO 1.15. – Statistics.

Figure 4.6

<u>MID-PHASE.</u>	<u>END-PHASE.</u>
TO 1.1	TO 1.3
TO 1.2	TO 1.10
TO 1.4	TO 1.11
TO 1.5	TO 1.13
TO 1.6	TO 1.14
TO 1.7	TO 1.15
TO 1.8	TO 1.8

Table 4.3 *Mid/End Phase Objectives*

Reference to the table alerts us to a further anomaly in addition to the two noted above. TO 1.8 appears in both the mid and end phase tests as this topic is introduced at a basic level during the initial phase and then extended during the later phase. This means that we may expect this TO to appear on all the maths consolidation/revision papers and all the exams, though this may not necessarily happen if sampling has been employed across the range of papers.

Going back to the nomographs, the mid-phase paper clearly does test all the mid-phase objectives. In addition, it is apparent that it also tests objective 1.10 which is listed as an end-phase objective. This is a peculiarity that requires further qualitative analysis. We can see from the nomograph that question number 11 tests this unaccountable objective, and by turning to that question we should be able to make a more appropriate judgement as to why it is included, and indeed, whether it should be there at all. Question 11 in fact relates to 'linear equations', and requires the students to solve a number of linear equations where the unknown appears twice. So why is it included here? To find out the answer to this question we must refer back to the instructional specification. The nomograph indicates that question 11 also tests objective 1.5, hence there may be a clue here that helps us to find the answer. Indeed, qualitative analysis of TO 1.5 shows that one of the enabling objectives included here does require students to solve simple linear equations. This work is extended during TO 1.10 to include linear simultaneous equations and simultaneous linear and quadratic equations, hence, at this stage in the proceedings, the testing of linear equations would seem to be valid.

Moving on to the end phase consolidation paper, this is more ambiguous. Some of the objectives taught during the initial phase support the work done later in the course, consequently, some of the TOs such as 1.2 which includes basic arithmetic and indices, and 1.5 that includes transposition of formulae constantly re-appear as students undertake the more advanced work in the latter part of the course. TO 1.1 is tested by 8 of the 12 questions which appear on this paper as indicated by the large number of questions that map to this objective. So what of the two papers together? The most important point to emerge, in my opinion, is that TO 1.14 is not tested at all. This TO relates to 'complex numbers' which are allocated a significant amount of time in the syllabus. Statistics also seems to be under tested, this topic again is extensively covered by the syllabus but appears only once in the consolidation papers. As expected TO 1.1 is the objective which is tested the most, with TOs 1.5, 1.7 and 1.11 also very prominent. Overall, a fairly healthy degree of 'content validity' seems evident with the exception of the one topic which has presumably been overlooked in error.

To go through all the assessment instruments that I have tested in this way would be a laborious exercise for both the researcher and the reader, hence, the nomographs for the electrical principles AC revision paper and the engineering science circular motion post tests are included as appendices (T) and (U) at the rear of this report where the reader may draw their own conclusions. Where I shall now turn my attention, is to the summative examinations, as these require analysis on a second level to establish whether the weightings between marks allocated and syllabus time are valid. Three examinations were analysed for the purposes of this study, the mid & end phase maths exams (versions J & M respectively), and, the materials science end phase exam (version B).

Content Validity Level 2 – Is there Correlation between Marks Allocated during Summative Assessment and Syllabus Hours?

The initial phase of the analysis for these instruments was identical to that outlined above, mapping assessment tasks to training objectives, followed up by qualitative analysis. This exercise showed a high level of correlation, though as one may expect, not all objectives were tested by the combination of exams under investigation for the maths, as this in itself represents a sampling process. The materials science, where

there is just one end phase exam was much better in this respect with all TO's tested by the paper. The nomographs resulting from this exercise are included as appendices (V) to (X) at the rear of this report.

On the second level, a new approach was required to establish weighting validity. Again, this was nomograph based, though in this case there were three variables as opposed to two, namely, the training objective, the % of marks allocated to each assessment task, and, the % of overall time allocated to those same tasks within the syllabus. The weighting nomograph for the maths exams (J & M), is included as Figure 4.7 overleaf. You will note that both exams are considered simultaneously in this case, as a better picture may be established by treating them as a single entity.

Consider the nomograph. Each green line maps a training objective (TO) to the percentage of time allocated to it within the syllabus. (i.e. syllabus weighting). Each red line maps those same TOs to the percentage of marks allocated to them by the examination questions. (ie. assessment weighting). If there is correlation the green line which leaves each individual TO should reach the same height on the vertical scale as its corresponding red line. This would show that the assessment weighting for a particular TO correlated with its syllabus weighting. If, however, the green line leaving a TO finishes higher up the vertical scale than its corresponding red line, this would show that the % of time allocated to a TO in the syllabus was higher than the % of marks awarded to that same TO within the summative examination. Likewise, a red line finishing higher than its corresponding green line shows that the % of marks awarded during the summative examination, is higher than the % of time allocated to a particular TO within the syllabus.

So what of our analysis? Let us take a few points from the graph and analyse them more closely. If we look at TO 1.8 on the horizontal scale and follow the green and red lines for that TO up their respective scales we can see that both finish somewhere around 20%. For graphs and linear laws (TO 1.8), therefore, the time allocated within the syllabus is adequately reflected by the marks awarded to that topic during the summative exams. If we analyse TO 1.15 statistics, however, you will note a fairly large discrepancy, with the green line showing that about 6.3% of the total

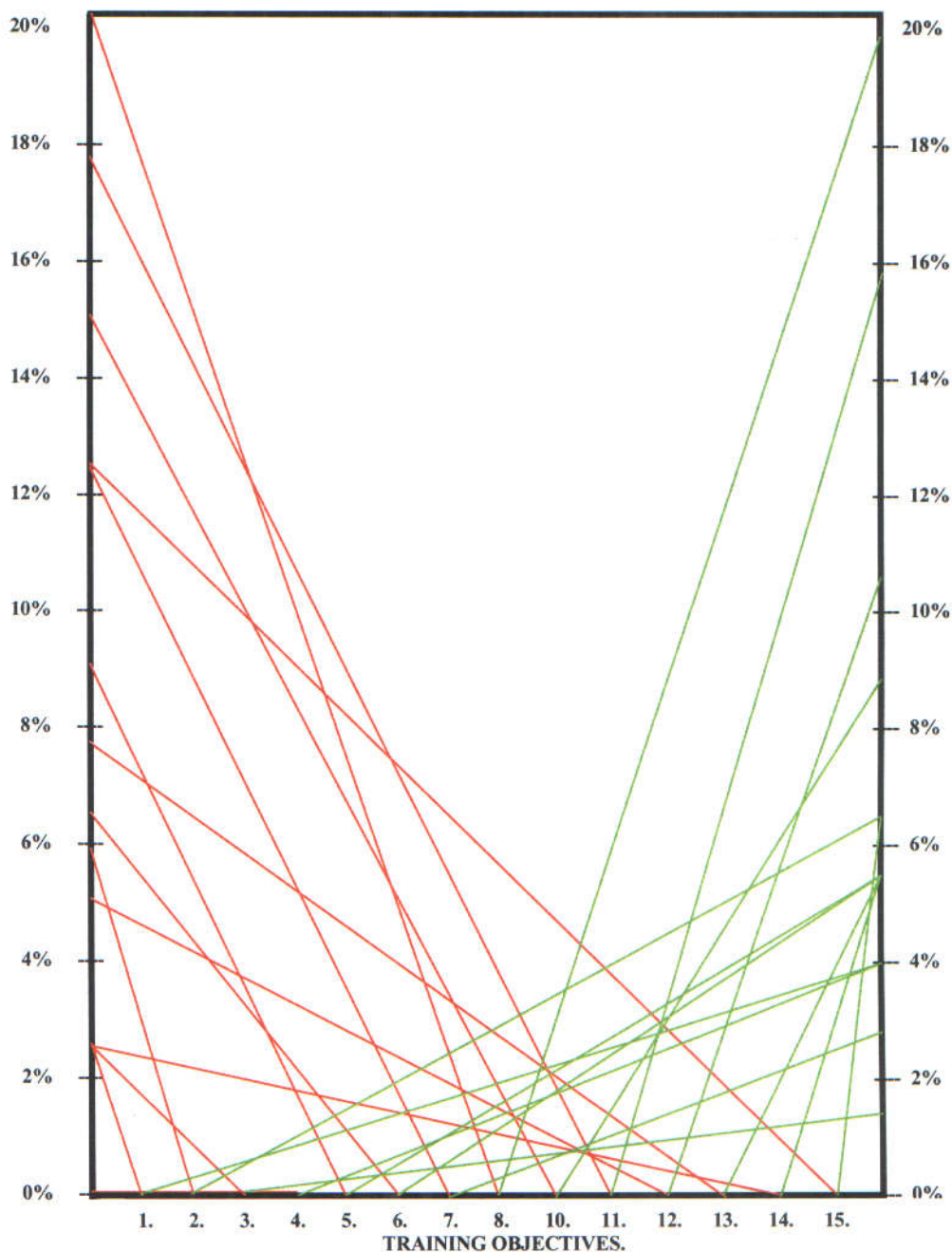
CONTENT VALIDITY – (Assessment Weighting/Syllabus Weighting).

ASSESSMENT
WEIGHTING.

ASSESSMENT
INSTRUMENT:

Maths mid (J) and end (M) exams.

SYLLABUS
WEIGHTING.



Key to Training Objectives:

TO 1.1. – Electronic Aids.

TO 1.2. – Decimals, Percentages,
Indices & Logarithms.

TO 1.3. – Tables & Charts.

TO 1.4. – Numbering & Measuring
Systems.

TO 1.5. – Formulae & Substitution.

TO 1.6. – Areas, Perimeters & Mass.

TO 1.7. – Surface Area & Volume.

TO 1.8. – Graphs & Linear Laws.

TO 1.10. – Linear, Quadratic &
Simultaneous Eqn's.

TO 1.11. – Calculus

TO 1.12. – Trigonometry.

TO 1.13. – Vectors.

TO 1.14. – Complex Numbers.

TO 1.15. – Statistics.

Figure 4.7

syllabus time is allocated to this topic but, the red line shows that about 12.2% of the total marks during summative assessment are focused on this topic. Almost twice the amount one would expect! TO 1.14 shows the opposite effect, and close scrutiny reveals that TO 1.4, numbering and measuring systems, is not tested at all. The weightings for this combination of maths exams are summarised in table 4.4 overleaf:

As the table shows, for the purpose of this study, $\pm 2\%$ has been considered as an acceptable degree of correlation. This figure is based on the accepted tolerance for standard confidence levels which is normally deemed to be between 1% and 5% (see Leonard - 1971). The most serious deviations are for objective 1.7 which shows that the marks awarded are some 9.5% higher than they should be, and, objectives 1.10, 1.12 and 1.15 which show 6.0% deviations one way or the other. If we accept the $\pm 2\%$ tolerance described above, this is an unacceptable level which ultimately weakens content validity.

Finally, we must consider the third level of analysis which we have identified as being important to content validity. This relates to the type of issue raised by Dawson & Thomas (1972), which was reviewed on page 26 of this report, and it leads us to a further qualitative analysis of the instruments under investigation to search for other obvious areas of weakness concerning content validity.

TRAINING OBJECTIVE.	SYLLABUS WEIGHTING.	ASSESSMENT WEIGHTING.
1.1.	WITHIN + OR - 2%	
1.2	WITHIN + OR - 2%	
1.3	WITHIN + OR - 2%	
1.4	THIS OBJECTIVE NOT TESTED.	
1.5		+ 3.5%
1.6	WITHIN + OR - 2%	
1.7		+ 9.5%
1.8	WITHIN + OR - 2%	
1.10		+ 6.0%
1.11	WITHIN + OR - 2%	
1.12	+6.0%	
1.13	WITHIN + OR - 2%	
1.14	+3.0%	
1.15		+ 6.0%

Summary of Weighting Correlation.

Table 4.4

Content Validity Level 3 - Other Areas of Weakness.

Dawson & Thomas alert us to the fact that a choice of 5 questions from 9 results in 126 combinations from which the student may choose, thus rendering any statistical analysis of student results invalid on the basis that theoretically 126 different paper contents may be sampled by the students. Clearly, this has implications for content validity, particularly when there are no checks or guarantees that the questions are of equivalent difficulty and no guarantee that students of equivalent ability will perform equally well regardless of which questions they choose to answer.

Of the ten instruments chosen for this investigation, the issue of 'choice' only impacts on 2 of them, though I know from my own experience, that it is more deep rooted than this as many of the engineering science examinations used at RAF Cosford are based upon a student choice. Lets stick to our sample, however, and go back to our mathematics mid & end phase examinations. The structure of the papers is such that in both cases we have two sections. Section (a) has twelve compulsory questions worth 5 marks each. These are short questions of the type we analysed on page 92, and cover a range of objectives. Section (b) gives students a choice of 2 from 3 more involved questions of the type analysed on page 94. These questions are worth 20 marks each, and again cover a range of objectives. Though the problem is not as acute as in the case described by Dawson & Thomas, there is evidence here that content validity is weakened. We can work out the number of combinations in this case by using factorial notation:

$$\frac{3!}{1! \ 2!} = \frac{(3 \times 2 \times 1)}{((1 \times 1) \times (2 \times 1))} = 3 \text{ combinations.}$$

With small numbers such as this, we could quite easily have worked this out by other methods such as a mapping matrix. This approach also has the advantage of telling us what the combinations actually are, for example, in this case the student may choose questions 1 and 2, or, 1 and 3, or, 2 and 3 as these are the variations on offer. The implications are that theoretically we have three different papers all offering the students a different overall content, hence, any comparisons between students made on the basis of this are invalid, and indeed, the grading system itself - fail, pass, merit, distinction could be questioned on this basis.

Related to this is an issue that was mentioned earlier in this report regarding combinations of papers. With the maths for example, figure 4.1 on page 82 shows us that there are two summative exams - mid & end phase, and for each there must be a minimum of three versions available for use at any one time. We analysed one combination, mid phase (J) and end phase (M) for weighting and content but, if we use the matrix below, it is apparent that there are several more combinations available to the student:

		Mid-Phase		
		A	B	C
End-Phase	A	*	*	*
	B	*	*	*
	C	*	*	*

The mapping matrix shows that there are in fact 9 combinations of papers available to the student. This means that looking at the picture overall, we have 9 different contents being sampled by the students if the minimum number of papers are running. increase this to 5 versions of each which is more normal, and the number of combinations increases to 25, meaning that if 25 different classes take the papers, it is theoretically possible that each class will have sampled a different content and given the choice available within the papers, 3 variations may be evident within each class. Using this evidence it seems sensible to suggest that introducing student choice into summative assessment procedures has significant implications for 'content validity'. As we have seen, even a minimal choice of 2 from 3 questions introduces 6 variations and add to this possible paper combinations, and we have quite a serious discrepancy which impacts, not only upon any statistical analyses, but also, grading and certification of students.

Strand 3: What Theories of Learning Underpin the BTEC (NC) Academic Units at RAF Cosford?

There are three stages to this area of research, firstly, a documentary analysis to determine the underlying principles of teaching and learning at RAF Cosford, and;

secondly, non-participant observation to clarify the position within the classroom. Finally, there will be a documentary analysis of assignments to determine whether they are designed in accordance with BTEC requirements concerning 'experiential learning'. Data concerning 'content validity', assessment, and common skills will also be generated by this area of research, and will be discussed in subsequent stages of this research. My first task is to carry out some documentary analysis on the instructional specification (I.S.) for the materials science module. The format of this document is standard for all modules that lead to the BTEC (NC) award at RAF Cosford.

The Anatomy of the Instructional Specification.

For the purposes of analysis the instructional specification (I.S.), may be considered as having three distinct parts. Part 1 gives general information relating to the unit, including the aim and purpose of the module. It goes on to explain such things as page numbering and standards, and clarifies abbreviations that are included within the document. Part 2, simply lists the topics which are included within the module and prescribes cell/class sizes, based upon classroom size and available laboratory capacity. There is also a breakdown of hours to be spent on each topic which is categorised into classroom hours, practical hours and totals. This, represents useful information for the lecturer, and it is expanded within part 3, which also outlines the module objectives. These consist of training objectives (TOs), and enabling objectives (EOs), and these will be analysed in detail in a later stage of this report. I shall begin, however, by going back to part 1, and looking at the aim of the module and its purpose. The aim is reproduced below:

"The aim of the course is to train senior aircraftsmen in the trade of aircraft mechanic to junior technician standard in the trade of engineering technician, as specified in AP 3376A volume 1B, to develop the skills, knowledge and attitudes to enable them to be effective members of the RAF, and to meet the technical and educational standards set out in the Aircraft Engineering Trades Review (AETR). On successful completion of the course a BTEC (National) certificate in Aerospace Studies (mech) will be awarded."

Materials Science Instructional Specification (Page 1)

There are several characteristics of this aim which begin to give the game away. Firstly, it states quite clearly that we are "training" senior aircraftsmen in the trade of aircraft mechanic, and it goes on to say that we are going to "develop the skills,

knowledge and attitudes to enable them to be effective members of the RAF.” Let’s bear this in mind for a moment as we move on to analyse the purpose:

"The instructional specification defines in detail the required student achievements for the successful progress and subsequent completion of the course. The information in this I.S. will enable the training management to determine the precise employment of instructional staff and the utilization of material resources. It will provide the instructional staff with a precise brief on what is required from the student together with the constraints of time and method within which the instructors must operate.”

(ibid Page 1)

Again there are certain features of this statement that focus our attention, in particular, the final sentence which states: "It will provide instructional staff with a *precise* brief on what is required from the student together with the constraints of *time* and *method* within which the instructors *must* operate.”

Taking the aim and the purpose together, we begin to get a good idea about the theory of learning which underpins our work at RAF Cosford. Firstly, we are training as opposed to educating, and we are focusing on prescribed skills and attitudes. The method of delivery is dictated through the I.S. and there is no scope for deviation. The time for each element of learning is also stipulated and instructors must remain within this constraint. Time, in fact, continues to be an issue as we read further into the I.S. On page 5, we have the list of topics to be covered within the module, and at this point, the total time for each topic is broken down into classroom time and practical time. The topic list and time analysis are reproduced in table 4.5 below:

No.	TOPIC.	CELL SIZE	C	P	T
1.1.	Structure of Matter.	16	5	3	8
2.1.	Introduction to Materials.	16	5	3	8
2.2.	Materials and Forces.	16	4	2	6

4.2.	Creep.	16	2	2	4
5.1.	Polymers.	16	2	2	4
5.2.	Composites.	16	6	0	6
6.1.	Forming Materials.	16	4	0	4
8.1.	Examination.	16	2	0	2

NB: C = Classroom. P = Practical. T = Total

Material Science Topic Analysis.

Table 4.5

You will note from the table, that the maximum cell/class size for this module is 16. As stated earlier this figure is based upon the capacity of the classrooms, and the safe working limit for the laboratories. You will also note that of the 42 hours allowed for this module, 12 hours are specified for laboratory work, which includes time for any summative assignments. There are 28 hours of classroom theory and 2 hours for the end-phase examination. The topics listed here are expanded within part 3 which details the main content for the module. This is broken down into what are called training objectives and enabling objectives. An extract from part 3 is included as figure 4.8 overleaf with more detailed analysis below:

We have already come across training objectives (TOs) during our examination of content validity. We shall now analyse them more closely and try to establish their role in the theory of learning which underpins our work at RAF Cosford. The extract overleaf relates to topic No. 4.2 (Creep), and as you can see, some of the information included above is repeated for the convenience of the lecturer. I refer to the cell/class size and the allocation of hours. In addition, there is a significant amount of new information which we must investigate.

The reference/remarks column relates the TO in the I.S. to the relevant BTEC module. For instance, in the extract overleaf the number 14578F/2 tells us that this TO relates to BTEC module number 14578F section 2. The performance column

Reference a	Performance b	Conditions c	Standards d	Cell size	Allocation of hours		
					c f	p g	t h
BTEC 14578F/2	A5/4/2 <u>TRAINING OBJECTIVE</u> 2.0 Describe the terms and processes relating to creep.						
				16	2	2	4
	<u>ENABLING OBJECTIVE</u> 2.1 State what is meant by 'creep', to include: a. Primary. b. Secondary. c. Tertiary. 2.2 Describe the conditions that affect the rate of creep, to include: a. Temperature. b. Stress. c. Time. 2.3 Explain the creep properties of metals and interpret creep data, with reference to work hardening, recrystallisation and recovery. End of A5/4/2	In his own words.	Correctly.				
		In his own words.	Correctly.				
		In his own words given a selection of data.	Correctly.				

Materials Technology Instructional Specification (1582) RAF Cosford.

Figure 4.8

lists TO's and EOs, and, column (c) states the conditions through which the student must display competence in each listed objective. In this case, the conditions are "in his own words", hence, to test EO 2.1. for example, we would expect the student to be able to state, in writing, what is meant by 'creep'. His explanation would need to include reference to the primary, secondary and tertiary stages of creep as specified, and the standard for this as stipulated in column (d) is "correctly". This represents a standard layout for all instructional specifications at RAF Cosford.

Reflecting back to the TOs and EOs, I suggested within my literature review that there may be some correlation between 'applied behavioural analysis' and the approach taken at RAF Cosford. (see literature review page 34). You may remember that Cegelka & Lewis (1983), produced an instructional programme based upon applied behavioural analysis for the teaching of slope. This was reviewed on page 32 of this report. We must now consider whether this approach relates to the theory of learning which underpins our work, and if so, to what extent there is correlation between the two.

Cegelka & Lewis suggest that for this type of programme to succeed, two major types of behaviour must be identified:

- " i) The entry level skills of the students, and;
- ii) The desired terminal behaviour."

(1983 Page 174)

If we compare this to our own approach for teaching TO 2.0. (creep), we may find similarities in respect of the following:-

Entry Skills:-

- i) It is stated within the I.S. that pre-requisite knowledge is nil.

Target/Terminal Behaviours:-

- i) (TO 2.0.) The student will be able to describe the terms and processes relating to creep.

Having identified entry skills and target behaviour, Cengelka & Lewis go on to break the target behaviour down into what they call "sub-skills" (see page 34). These sub-skills may become target behaviours in themselves, their purpose, however, is to enable the students to reach their "goal". (1983 page 174). We may relate these sub-skills to our EOs as shown below:-

Sub-Skills:

i) (EO 2.1) The student will be able to state what is meant by "creep" to include:-

- a) Primary
- b) Secondary.
- c) Tertiary.

in his own words correctly.

ii) (EO 2.2) The student will be able to describe the conditions that affect the rate of creep, to include:-

- a) Temperature
- b) Stress.

in his own words correctly.

iii) (EO 2.3) The student will be able to explain creep properties of metals and interpret creep data, with reference to work hardening, recrystallisation, and recovery.

in his own words, given a selection of creep data, correctly.

It is evident that there are many similarities so far. In our case the students don't require any entry skills, the target behaviour is represented by the TO and, the sub-skills which the student must achieve to reach the target behaviour are represented by the EOs. To put it another way, the TO represents the 'product', and the EOs represent the 'process' through which that product is achieved.

Having identified entry skills, target behaviours and sub-skills for their own programme, Cegelka & Lewis go on to suggest that each sub-skill requires a sub-programme, and each sub-programme should include:-

- i) Presentation of task.**
- ii) Opportunity for practice, and;**
- iii) Assessment of mastery.**

Here, we have moved beyond the scope of the instructional specification, as this part of the strategy must be determined by the lecturer. We cannot, therefore, determine whether sub-programmes of this type are in evidence without entering the classroom and carrying out some non-participant observation. My observation schedule for this purpose appeared within the methodology section of this investigation and is included as appendix (K), at the rear of this report.

Applied Behavioural Analysis Observed.

Three lessons were observed during this procedure, and analysis of the results led me to several conclusions. As one might expect, each individual enjoys their own method of presenting tasks to students, and in the three cases I observed these varied from one lecturer who presented it by viewfoil (Lecturer A), to another, who had prepared a text based handout (Lecturer B), to the third, who simply made a verbal delivery supported by some notes and examples on the whiteboard (Lecturer C). All three lecturers gave worked examples, but again, these were delivered in different formats. Lecturer A, had some worked examples on transparency, and simply went through each, moving a piece of paper down the screen as he presented each procedure. Lecturer B, had included several worked examples in his handout, but also, covered several more on the whiteboard, and; as noted above, lecturer C, used the whiteboard for his delivery. Regardless of the different approach to 'presenting the task', it is evident that this part of the sub-programme was in line with Cegelka & Lewis's description. Each instructor presented the task in his own way as he guided students towards the target behaviour.

The second phase of the sub-programme requires each student to have an opportunity to practice each sub-skill, or in our case, each EO Again, each of the three instructors

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The second phase of the sub-programme requires each student to have an opportunity to practice each sub-skill, or in our case, each EO Again, each of the three instructors

who agreed for their lessons to be observed had their own methods of providing such opportunities. As one might expect, lecturer A, had an exercise on transparency which each student attempted after copying down the worked examples. He gave help where needed during the exercise, and appeared to be engaged in some sort of contingency teaching (see Wood (1990)), offering just enough help to enable students to take the initiative. He provided worked solutions, again on viewfoil, introducing these in stages as the exercise progressed. Students who had got a question wrong, were asked to study the worked solutions and clarify any misunderstandings. Lecturer B, as one might also expect, provided a text based exercise. This was part of the original handout. It involved a series of exercises which brought in new sub-skills (EOs) as the student worked through the booklet. Worked solutions were not provided, but the unworked solutions were given on the final page. As in the previous case, lecturer B, gave help where required as the exercise progressed, and if a specific question seemed to be causing widespread problems, he went over it, providing a worked solution on the whiteboard. Lecturer C had no pre-prepared package, but made up an exercise on the whiteboard. He offered help where necessary, but not so willingly as in the previous two cases. It was significant to note, that because help wasn't so forthcoming from the instructor, students were more reliant on each other, discussing problems and drawing general conclusions. At the end of the opportunity for practice lecturer C went over each question very thoroughly on the whiteboard. Students copied down the worked solutions at their discretion.

Finally, I was interested in how each instructor assessed mastery of the sub-skills (EOs) taught. Lecturer A, actually moved into text mode at this stage and provided the class with a formative consolidation sheet. He stated that he would provide worked solutions in text form at the next lesson. Lecturer B, had included a formative post test at the end of his handout. He had also included unworked solutions and stated that he would go over any problems at the outset of the following lesson. Lecturer C, didn't engage in any kind of assessment, but directed students to some exercises in the textbook if they wished for further practice. He suggested that students tried to get together in small groups during the evenings to sort out any problems, and also stated that he would re-visit the sub-skills taught during revision.

So what conclusions may we draw from this observation exercise? The original purpose was to determine whether sub-programmes formed part of the overall learning strategy. The sub-programme that I am interested in was based upon that described by Cegelka & Lewis (1983) and involved presenting each sub-skill as a task, providing opportunities for student practice, and finally, assessing whether each student had achieved mastery in the sub-skill. Each sub-skill, or in our case, enabling objective, represents a required behaviour in achieving the ultimate target behaviour or, training objective. We also likened these to 'product' and 'process' objectives. At the end of the exercise we may conclude that in the three lessons observed, there was indeed some evidence to suggest that sub-programmes form part of the overall approach. The only missing element was the assessment of mastery in the case of lecturer C, but even here, there was evidence to suggest that this may take part at a later stage in the process. It seems worthy of note, that I found no evidence of an information processing approach of the type described by Larkin (1983). It seems apparent that what is happening at RAF Cosford is a form of applied behaviourism, which is somewhat similar to that described by Cegelka & Lewis.

Is there Evidence of Experiential Learning as Advocated by BTEC (1998)?

As noted within my literature review, BTEC have become great advocates of 'experiential learning', and suggest ways that an experiential approach may be incorporated into their academic modules (BTEC/EDEXCEL 1998). In view of their suggestions, I decided that the best method of ascertaining whether such an approach is in evidence at RAF Cosford was to carry out a documentary analysis on a sample of assignments. These were selected by stratified random sampling as described earlier in this report (see methodology page 65). My approach presented the opportunity to gather data on a number of issues that are pertinent to this study, and which are included within the overall analysis.

Ten assignments were analysed for the purposes of this study, and though it is not necessary to present all the data, I feel that it is appropriate to present information and data analysis for one of the assignments for the purposes of explanation. Reference to figure 4.9 on page 122, shows data resulting from a documentary analysis of an engineering science assignment. This data resulted from a detailed evaluation which

was carried out by myself and later repeated by a colleague at RAF Cosford for the purposes of validation. Correlation between our findings seemed to indicate a good level of reliability thus increasing the validity of the system overall. Figure 4.10 which appears on page 123, shows how the data has been recorded in polar form to give a graphical representation which clearly shows areas of weakness. A regular hexadecagon would indicate a perfect assignment in the areas under investigation. As you can see, in this instance, the assignment under evaluation has come through very strongly, with only a few areas showing signs of weakness. Figure 4.11 on page 124, shows how data has been broken down into specific areas. Questions 1 - 4 relate to content validity, and questions 9 - 12 show data relating to experiential learning. In each case, a perfect square indicates a perfect scenario in the area concerned; the many variations show weaknesses that may be identified by referring back to figure 4.9. In this case, you will note some signs of weakness where group work is concerned, though all in all, this assignment comes through very strongly, with a suitable assessment scheme indicated by the perfect square. A diagrammatic summary of results from this area of research is included as figure 4.12 on page 125 of this report:

DOCUMENTARY ASSIGNMENT ANALYSIS.

Module No. & Title: *BTEC (NC) Engineering Science.*

Assignment No. & Title: *The Principle of Moments (No.2).*

Assignment Characteristic.	Positive ←————→ Negative					
	5	4	3	2	1	0
1. Is the assignment realistic?		x				
2. Does it test relevant outcomes?	x					
3. Is the degree of difficulty correct?	x					
4. Does it reflect the TO's and EOs in the I.S.?	x					
5. Are there opportunities for individual planning?	x					
6. Are there opportunities for group planning?			x			
7. Are there opportunities for individual tasks?	x					
8. Are there opportunities for group tasks?			x			
9. Does it provide opportunities for conceptualisation?		x				
10. Does it provide opportunities to plan an activity?	x					
11. Does it provide opportunities for experimentation?		x				
12. Does it provide opportunities for reflection?	x					
13. Is there an assessment scheme?	x					
14. Is the assessment criteria made clear?	x					
15. Does the grading criteria reflect the BTEC principles for performance beyond a pass?	x					
16. Are there opportunities for the assessment of common skills?	x					

Figure 4.9

ASSIGNMENT STATISTICS ANALYSIS.

Module No. & Title: *BTEC (National) Engineering Science.*

Assignment No. & Title: *The principle of Moments (No.2).*

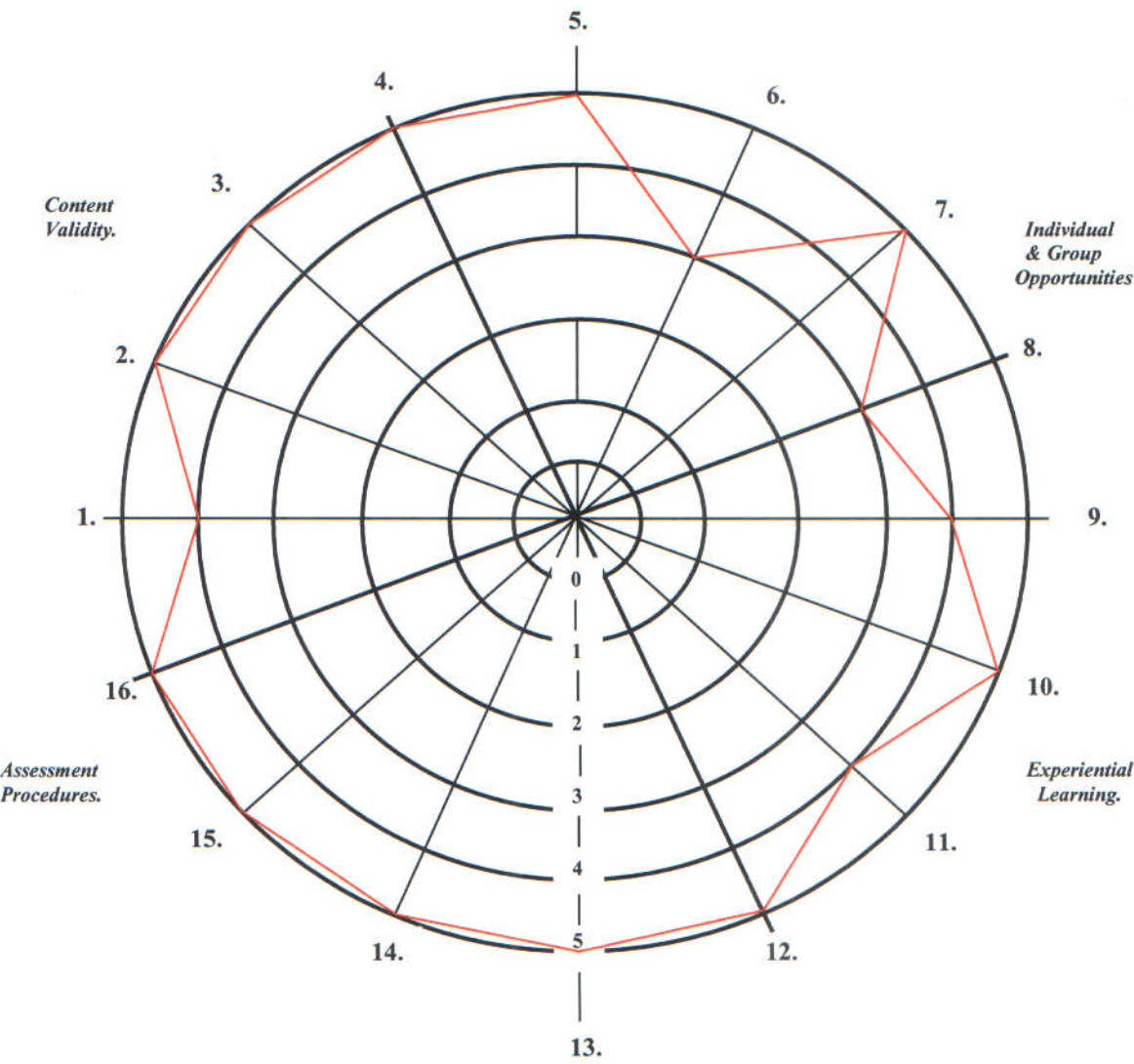
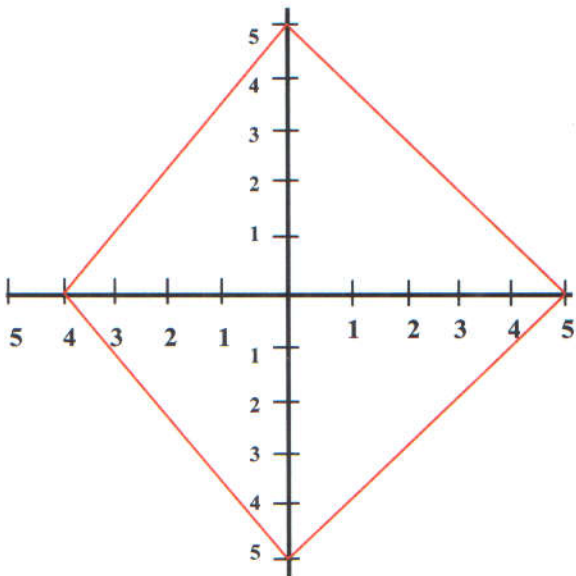


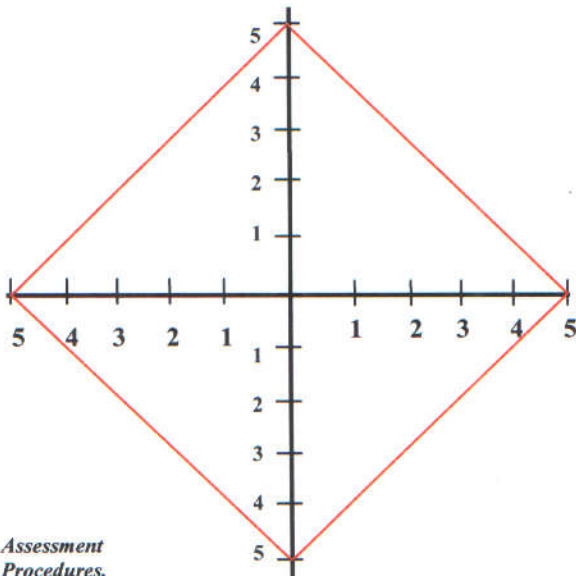
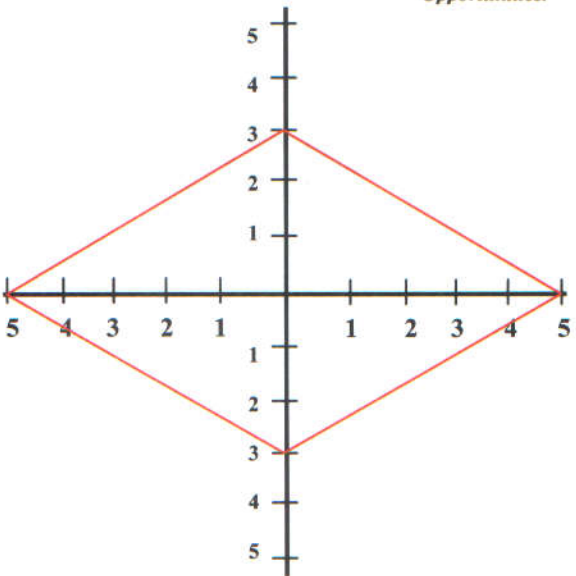
Figure 4.10

ASSIGNMENT STATISTICS ANALYSIS.

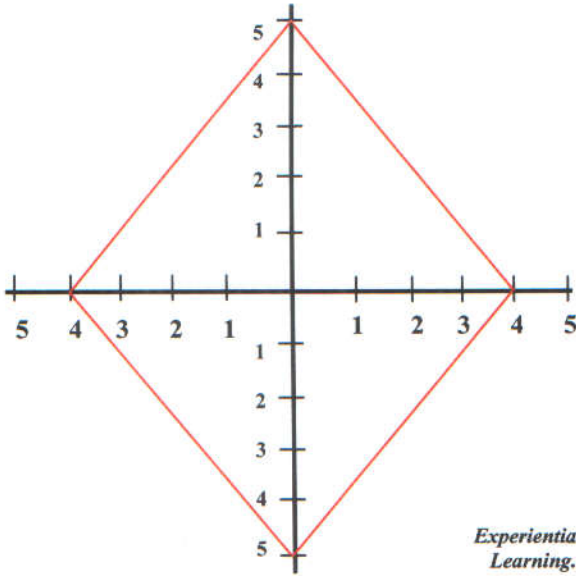
Content Validity.



Individual &
Group
Opportunities.



Assessment
Procedures.



Experiential
Learning.

Figure 4.11

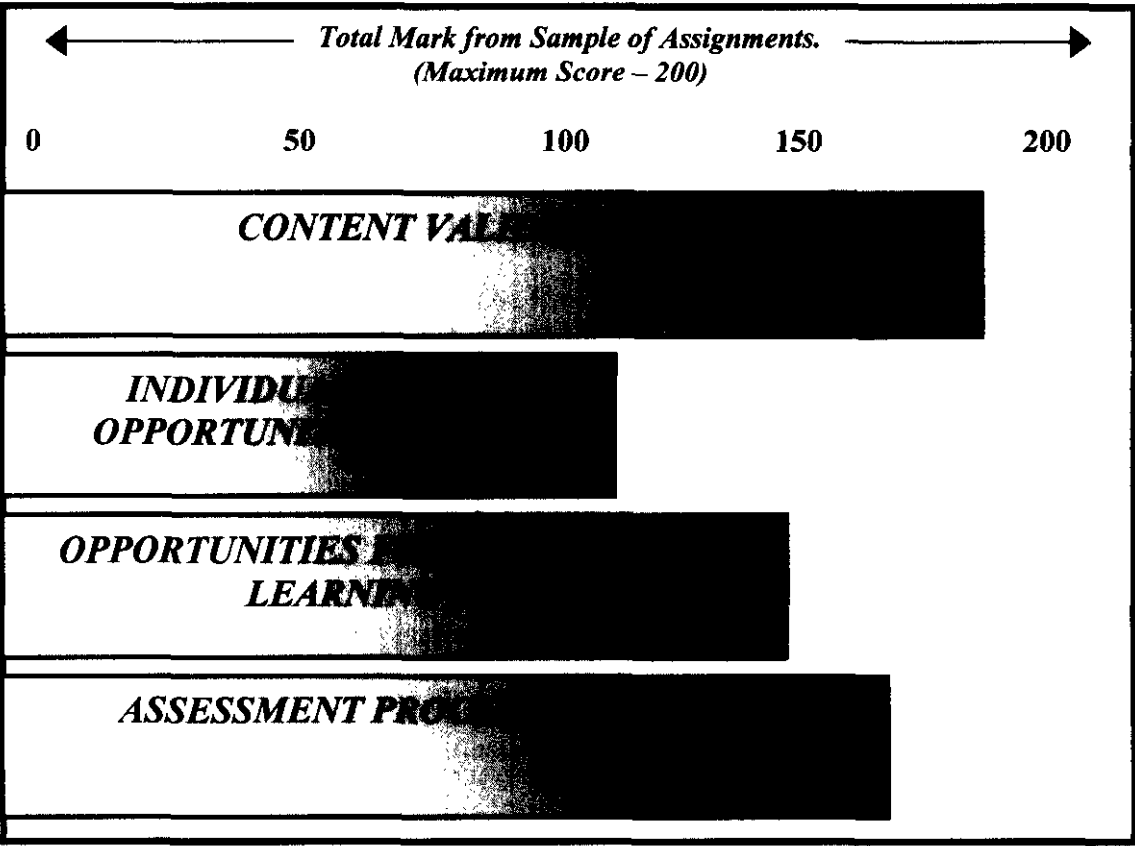


Figure 4.12

If we analyse the above graphic in conjunction with figures 4.9 to 4.11, the following points are apparent:

- Content validity is at a high level overall. All the marks dropped in this area related to question 1, 'Is the assignment realistic'?
- The assignments showed some weakness in providing opportunities for group work. This, of course, impacts on 'common skills', and should be addressed.
- This area of research revealed differences across subject boundaries. The engineering science assignments that are laboratory based provided good opportunities for experiential learning. The materials science assignments showed considerable weaknesses tending to be over prescriptive.
- All the assignments within the sample were accompanied by an assessment scheme, but there were possible weaknesses in the grading criteria in some of the cases analysed. A number of the assignments had no means of grading student performance beyond a pass, and another displayed inadequate criteria for this purpose. In accepting that grading levels beyond 'pass' are not always necessary, this issue may require closer analysis.

Strand 4 - What is the relationship between individual learning styles and student performance in different areas of BTEC (NC) summative assessment?

The Results.

As outlined within the methodology section of this report, my findings will be published under a number of sub-headings. In the first instance, having tested and scored 100 students using Honey & Mumfords LSQ (see appendix (C)) I plotted each individual result onto a polar graph. The results of this analysis are shown as figure 4.13 overleaf:

The purpose of the polar graph is to show the spread of the sample and to provide a quick visual check of numbers in each level of significance. Any 'clusters' of learners also become evident. Analysis of the graph confirms that many of the learners in the sample fall into levels 2 and 3 (see pages 70/71). Learners with a modulus ≥ 15 , which shows a very significant preference towards a particular style are rare, and just 6 'hub' learners with a modulus < 2 are evident in the sample.

As one might expect, the majority of the sample are clustered around the 135° - 315° diagonal showing that activist/pragmatists and reflector/theorists are the most likely combination of preferences for an individual. Activist/reflectors and pragmatist/theorists are far less likely though they are possible at less significant levels. The blue dots on the graph show Honey & Mumford's norms for the general population ($3.2 \angle 268.21^{\circ}$) and a sample of engineering graduates ($3.9 \angle 292.62^{\circ}$) (Honey & Mumford 1986, Page 77). Both these scores give a rating of $\delta 3$ showing a tendency towards the theorist style of learning. It is apparent that the engineering sample shows slightly less significant theorist tendencies than those for the general population. This is clear from the polar graph.

Pattern of Individual Learning Styles.

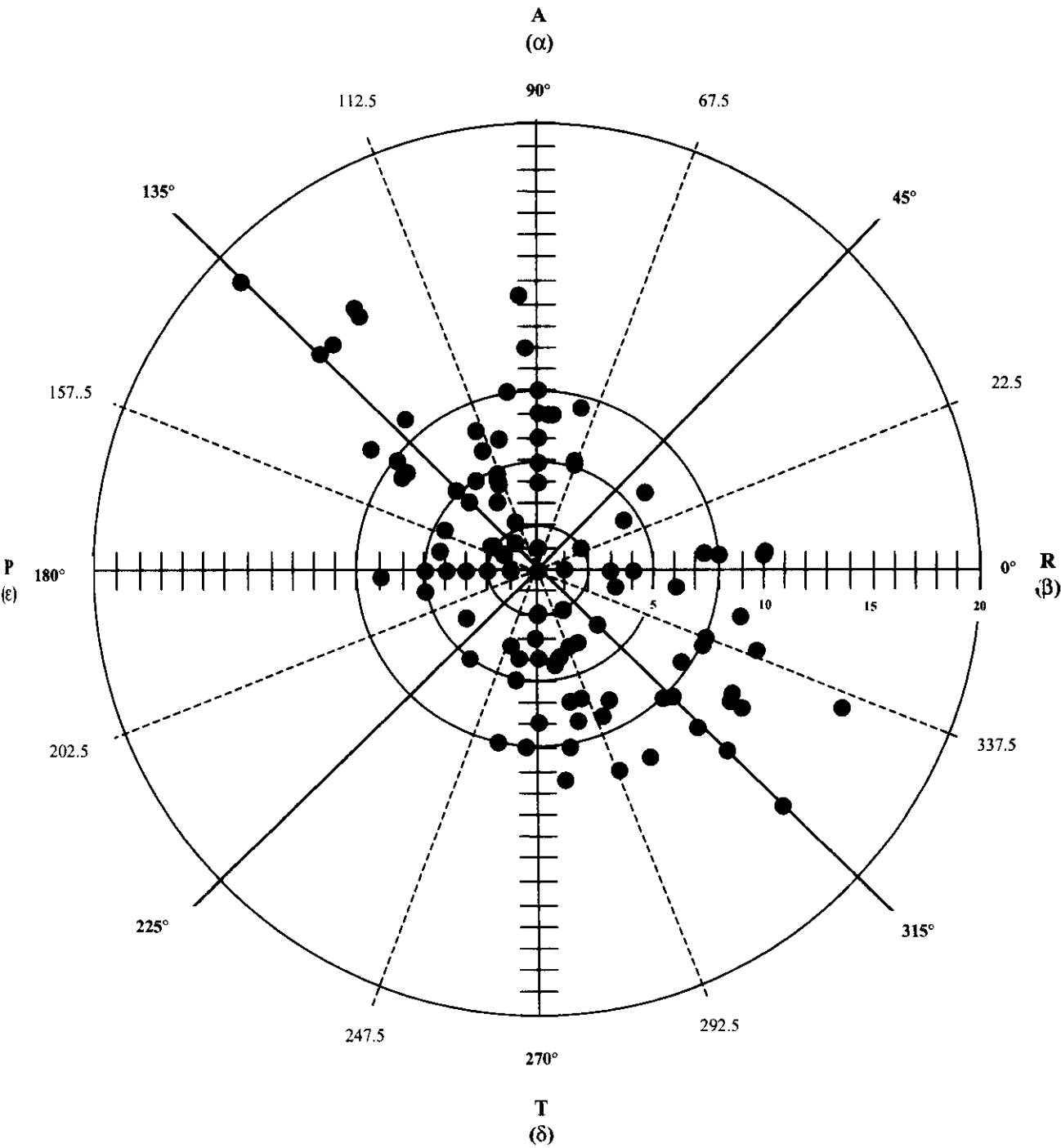


Figure 4.13

Are Certain Types of Learner either Advantaged or Disadvantaged during Summative Assessment on the BTEC (NC) Academic Units?

Following on from the polar graph, I was interested in establishing whether a relationship existed between the individual learning styles identified by the LSQ and performance overall on the five summative assessment episodes chosen for this analysis. There were four parts to this area of research which began with drawing up tables of results for each student in the sample under their individual learning style and then categorising them under their learning style level. I also drew up a table of assessment results for each of the four learning style groups, which included all students in levels 1 - 3, and in addition a table which included all students in the sample including the 'hub' learners. Analysis of these tables would provide the 'norms' and 'expected values' for the statistical analysis which was to follow. The tables for activists (α), reflectors (β), theorists (δ) and pragmatists (ϵ) at levels 1 – 3 are included as appendices (Y) to (BB) at the rear of this report.

When I first began my analysis of the tables I colour coded each different grade, which I then 'highlighted' to give a quick visual check as to which grade(s) were dominant for each learning style. (The colour coding is not shown on the tables which have been included in the appendix). I also worked out the percentage total of each grade attained on the five assessments for each of the four learning style groups. This not only clarified what had been ascertained visually through the colour coding, but also provided accurate figures to take the analysis forward and make valid comparisons between activists (α), reflectors (β), theorists (δ) and pragmatists (ϵ), and indeed, between the levels within each of the four groups. As can be seen from the tables and the percentage totals on the tables in the appendix, there are considerable differences overall between the grades achieved by each learning style group. You will also see as this section of my report progresses, that these differences become even more apparent as we begin to focus on the different levels within each category.

As a first step in this analysis, I took the percentage totals of each grade from each of the four style groups and compared the four sets of results to the percentage total of each grade attained by the sample as a whole. The purpose of this was to ascertain the probability of each category of results arising by chance, and my null hypothesis was that the differences between each category of learner and the overall sample of 100

could not have occurred by chance and are due in some measure to the students individual learning style. To test my null hypothesis I used the χ^2 test⁸. This test compares observed values with those that we may expect. The expected values I have used are those yielded by the full sample of 100 students, and these are compared to the values yielded by each of the four groups categorised by their individual learning styles. You will notice that percentage figures have not been used for this test as it would distort the results. My findings are published in table 4.6 below:

Activist Levels 1 - 3:

	Pass	Merit	Dist.	Fail
Observed (O)	52	48	13	7
Expected (E)	36	56	25	3
O - E	16	-8	-12	4
(O - E) ²	256	64	144	16
<u>(O - E)²</u> E	7.11	1.14	5.76	5.33

$$\chi^2 = 7.11 + 1.14 + 5.76 + 5.33 = 19.34$$

Table 4.6

To find the probability, I now look up χ^2 in the table of critical values⁹. This required me to work out the degrees of freedom (df) in my table which in this case is equal to - (Columns - 1). This gives me 3 df. Using this figure the probability of this set of results arising by chance is less than 1 in a 1000. (**p<0.001**). This seems to prove my null hypothesis and suggests that these results are at least partly due to the individual learning style of the individuals concerned. The probability of the results in the reflector, theorist and pragmatist categories are published below. The method above has been used for all chi-squared tests contained within this report.

⁸ This is known as the chi-squared test and is explained in the Open University E824 S.G. (Page 101).

⁹ I used the table of critical values in Galloway. D., Gent.A.M., Hutton.J., & Payne.V. (1980).

Reflector Levels (β) 1 - 3: $p < 0.02$

Theorist Levels (δ) 1 - 3: $p < 0.2$

Pragmatist Levels (ϵ) 1 - 3: $p < 0.8$

As statisticians do not take seriously any probability greater than 0.05 (E824 S.G), we may conclude that in this case the activist (α) group and the reflector (β) group warrant further investigation at levels 1 - 3. The theorist (δ) group with a probability of less than 0.2 remain interesting, while the pragmatists (ϵ) with a probability rating of approximately 0.8 are far to high to make any valid assumptions in this case.

Having analysed the results for levels 1 - 3 as a whole, I went on to focus on each level in turn. Again the chi-squared test was used to establish which groups required further investigation. The probability ratings for each of the levels are summarised in table 4.7 below:

	Activists (α)	Reflectors (β)	Theorists (δ)	Pragmatists (ϵ)
Level 1.	$p<0.001$	$p<0.05$	$p<0.5$	$p<0.8$
Level 2.	$p<0.1$	$p<0.2$	$p<0.2$	$p<0.5$
Level 3.	$p<0.8$	$p<0.98$	$p<0.5$	$p<0.8$

Summary of Chi-Squared Test Results.

Table 4.7

From the evidence above it is possible to make a number of assumptions. The probability rating for the activist group at level 1 suggests that there is less than a one in a thousand chance that the assessment results achieved by that group of learners occurred by chance. We must therefore assume, that there is some other reason for these results being so far removed from the expected values that I deduced from the overall sample. In my opinion, though there are other factors to be considered, I would suggest that this was due at least in part, to the individual learning style of the students. This is not the case with the majority of the other groups of learners within the sample, though the rating for the level 1 reflectors also shows that this set of results are unlikely to have occurred by chance. With the exception of the pragmatists, the probability rating for the level 2 groups, is also reasonably low, hence, I would suggest that there is also a reasonable case for further investigation of these groups. If there is a one in ten probability that the scores occurred by chance, then there is a nine

in ten probability that they didn't. Although not of statistical significance, these odds at least justify further probing if I am to prove my null hypothesis.

Apparent Differences in Assessment Performance by Learners at Levels 1 - 3 Combined.

If we accept that all learners with a modulus >2 display a significant preference towards one learning style or another, then the sample which includes all learners at levels 1 - 3 may be used to evaluate assessment performance in terms of the number of Passes, Merits, Distinctions and Fails attained by each of the learning style groups. Analysis of figure 4.14 which is included overleaf, provides a graphical representation of the grades awarded to different types of learner within the sample on the five assessment episodes which form the basis of this study. By reference to the red line on the graph, we may ascertain that approximately 43% of the grades awarded to activists (α) were pass grades. In addition, approximately 40% were merits, 12% distinctions and 6% fails. We may compare this to the grades awarded to reflectors (β), theorists (δ) and pragmatists (ϵ) and make some comparisons as to which types of learner have been more successful and which least successful on the 5 assessments included in this study. The dotted line on the graph shows the results from the total sample including the 'hub' learners. These results may be regarded as the norms for the total sample of 100 learners.

It would appear from these findings that activists have been the least successful learners on the assessments under consideration. Their failure rate overall is higher than the other groups and they have attained the fewest number of merits and distinctions. The pragmatist group displays the least fail grades and on this basis may be considered as the most successful group. This is arguable, however, as both the theorists and the reflectors have attained a greater number of distinctions and their failure rates are not significantly higher than that recorded by the pragmatists. We may also note that the profiles for two of these three groups are very similar and also comparable to the sample norm. The Activist profile is less uniform and deviates from the norm in a number of areas, while the reflector profile also shows some diversity.

Performance Patterns at Levels 1-3 Across the Range of Assessments.

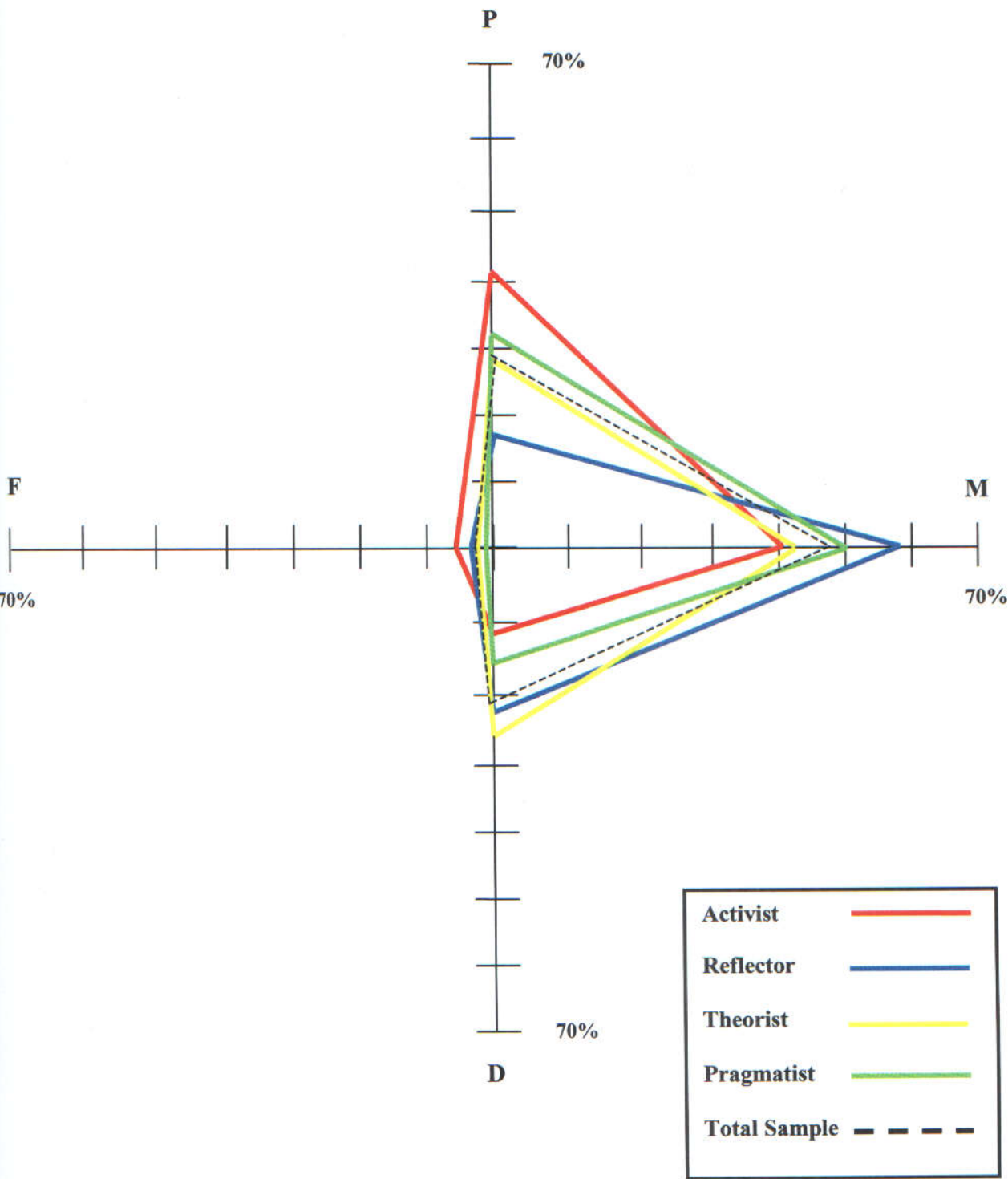


Figure 4.14

Apparent Differences in Assessment Performance by Learners at Different Levels of Significance.

If we focus upon the three levels of significance for each type of learner it seems evident that for certain learning styles there is a marked difference in assessment performance as we move from level 1 to level 3. The 4 graphs shown as figure 4.15 overleaf, show how the pattern of performance changes for each style on the five assessment episodes which form the focus of this study. The activist graph shows that learners with a level 1 significance have performed differently to their level 2 and level 3 counterparts. It is also apparent from this evidence that the level 2 and level 3 activists have achieved an almost identical pattern of performance if we take an overview of the five assessment episodes. It is interesting to note that all level 1 activists achieved either a 'pass' or 'merit' grade with no distinctions or fails evident in that category.

The reflector graph shows a different pattern of performance to the other 3 styles. The amount of pass grades achieved by level 1 reflectors is greatly reduced from the level 1 activists and there is a marked increase in merit and distinction grades. The profile for level 2 reflectors is similar to that of their level 1 counterparts though there is an increase in merit grades at this level and no fails recorded on any of the assessments.

The theorist group show more distinction grades than other types of learner with a particularly high number achieved at level 2. It is apparent, however, that there are far fewer theorists achieving this grade at level 3 as the preference for the theorist style becomes less significant and we move towards the hub. It is worth noting that the level 3 profile is similar for each of the four learning styles. This may possibly be due to the fact that learners become more similar at the less significant level thus making them distinguishable from learners who have a clear preference for one style or another. This idea will be subject to further discussion later in this report. Finally, the level 1 pragmatists are distinguishable from their level 2/3 counterparts due to their 7% fail rate. This may indicate that learners with a significant preference towards the pragmatist style perform badly on a certain type of assessment. If this is the case it should become more apparent in subsequent sections of this report. This apart, the pragmatist group are not particularly interesting as indicated by their high chi-squared probability rating. Their average profile at levels 1 – 3 is similar to that

Assessment Performance Patterns
at Levels 1 – 3.

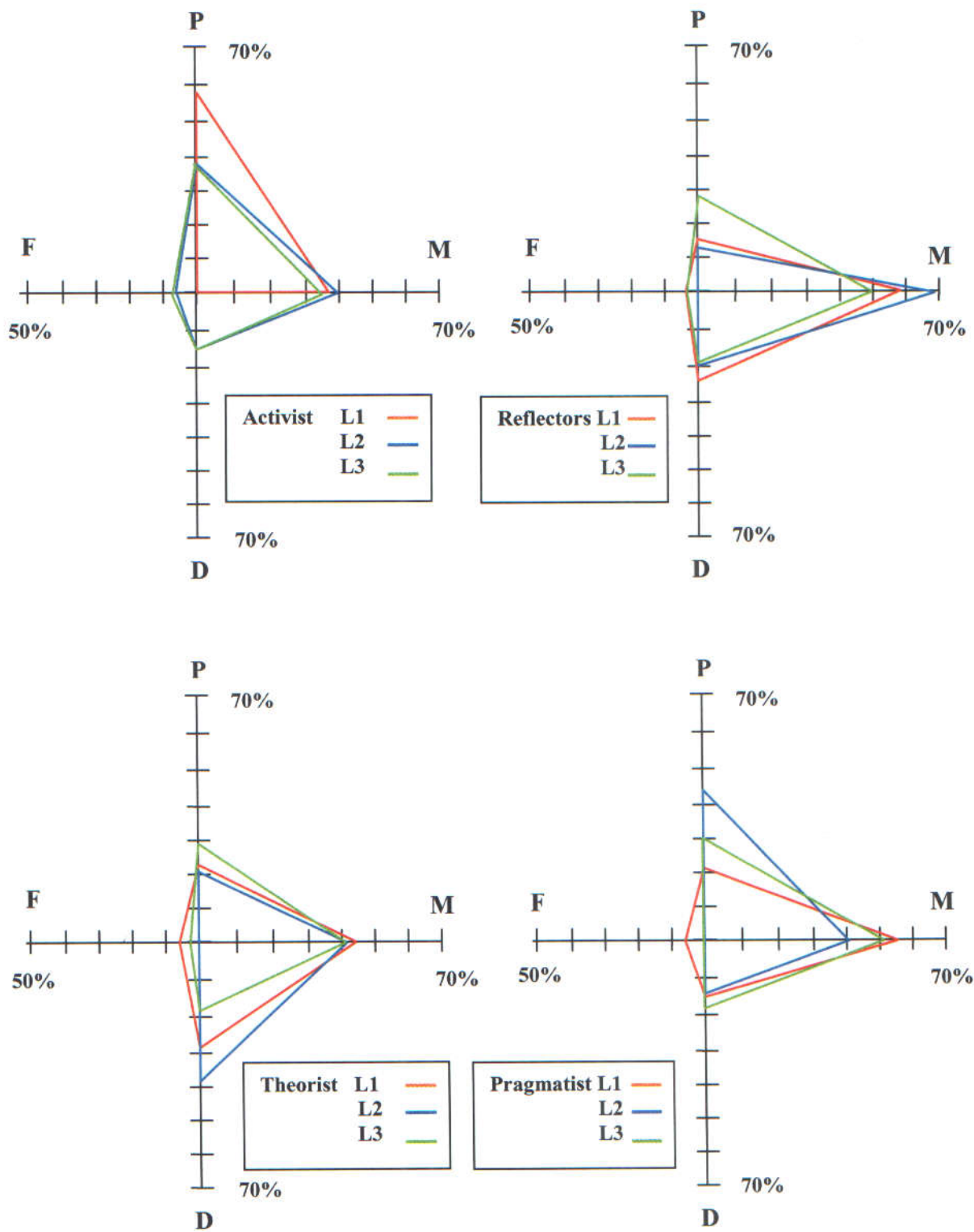


Figure 4.15

generated by the total sample and shows no significant differences in their performance pattern overall.

Learning Style Performance Patterns on Different Types of Assessment Episode.

AB100 (Mid-phase mathematics examination).

Analysis of performance patterns at levels 1 – 3 for the AB100 maths mid-phase exam, show some interesting differences between learners in the different learning style groups and a changing pattern of performance as we move from level 1 to level 3 for each type of learner. Reference to the AB100 graphs which are included as figure 4.16 overleaf shows that the activist profile (red line) is significantly different to that of the other three styles. Approximately 60% of the grades awarded to level 1 activists were ‘pass’ grades while they had an approximate 12% ‘fail’ rate and no ‘distinctions’. The number of ‘merit’ grades awarded to this group was also very low. This unusual profile is confirmed by the chi-squared rating for this group which shows that the probability of these results occurring by chance is less than one in a thousand ($p < 0.001$), it also contrasts sharply with the reflector group (blue line) who record a high percentage of merit and distinction grades for this exam, with a low number of pass grades and no fails.

As we move through the levels to level 3, the activist profile becomes more similar to that of the other three styles. This perhaps is not surprising, as level 3 learners have a less significant tendency towards a particular style and we may expect learners at this level to become more similar to each other. The reflector group at level 3 continue to perform well on this exam and show a particularly high proportion of distinction grades which is very similar to the theorist profile at level 2. If we compare the level 1 graph in the top left hand corner with the graph for the total sample on all exams in the bottom right, it seems to suggest that there are some significant differences in performance as the nature of assessment is changed. It is possible that this may reflect the different types of knowledge that are tested by the different assessment papers and this issue will become the focus of attention later in this report.

Assessment Performance Patterns at Levels 1 - 3.

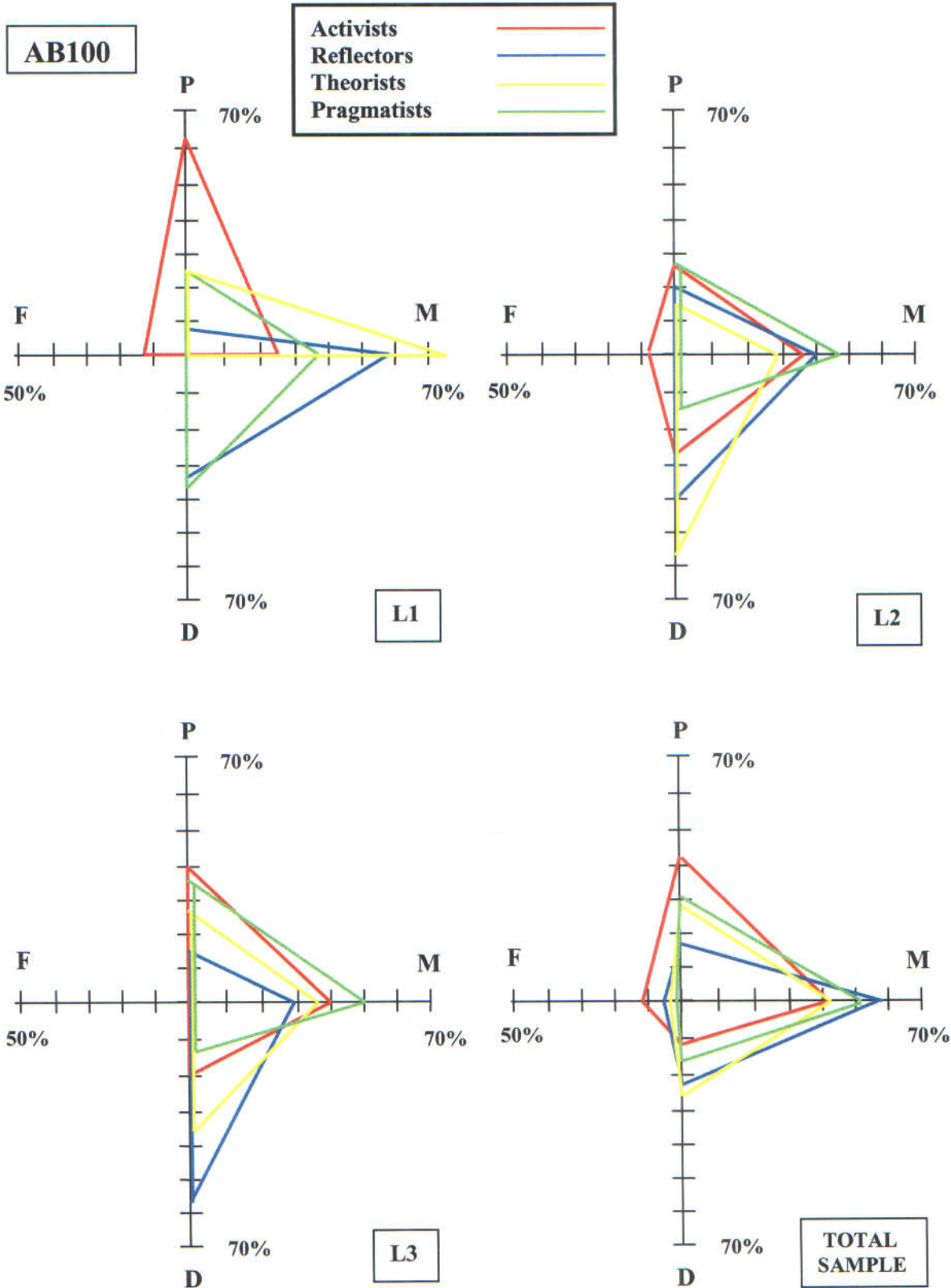


Figure 4.16

AB102 (End-phase mathematics examination).

The possible relationship between learning styles and assessment is reinforced by the performance patterns for the AB102 end-phase mathematics examination. The performance patterns for this assessment are included as figure 4.17 overleaf.

It is apparent that the level 1 activists in this case have recorded an even higher number of pass grades than those shown by the AB100 profiles. Significantly, there are no fails and no distinctions recorded by the activist level 1 group. In contrast, learners at level 1 for the other three styles show a significant number of fails whereas none were recorded for AB100. It is also interesting to note that as the tendency towards a particular style becomes less significant at level 2 the trend has reversed itself with the activist profile showing an approximate 20% fail rate and no fails recorded by any of the other three styles. In fact, the merit rate for reflectors at level 2 and the distinction rate for theorists is in excess of 70%. As we move to level 3 the performance patterns are beginning to look more like the general norms which are shown bottom right for the total sample.

AB598 (Materials science assignment).

Unlike the previous two cases (AB100/AB102) which are both formal mathematics examinations, AB598 is a written 'materials science' assignment that requires students to carry out a small investigation and submit a project of approximately 1000 words. The different nature of the assessment is reflected by the performance pattern profiles at levels 1 – 3, which are dissimilar to the previous cases and have several unusual features. Analysis of the AB598 graphs that are included as figure 4.18 on page 140, shows that no student in the sample, regardless of their learning style or level, has recorded a fail grade for this assessment. This contradicts the pattern of performance in the previous two cases and alerts us to an unusual anomaly. It is also a notable feature that the difference between the learning style profiles and the different levels in this case is not so marked as in the previous two cases. Apart from the lack of fail grades, which is noted above, the profiles at levels 1 and 2, are very similar to those produced by the total sample.

Assessment Performance Patterns at Levels 1 - 3.

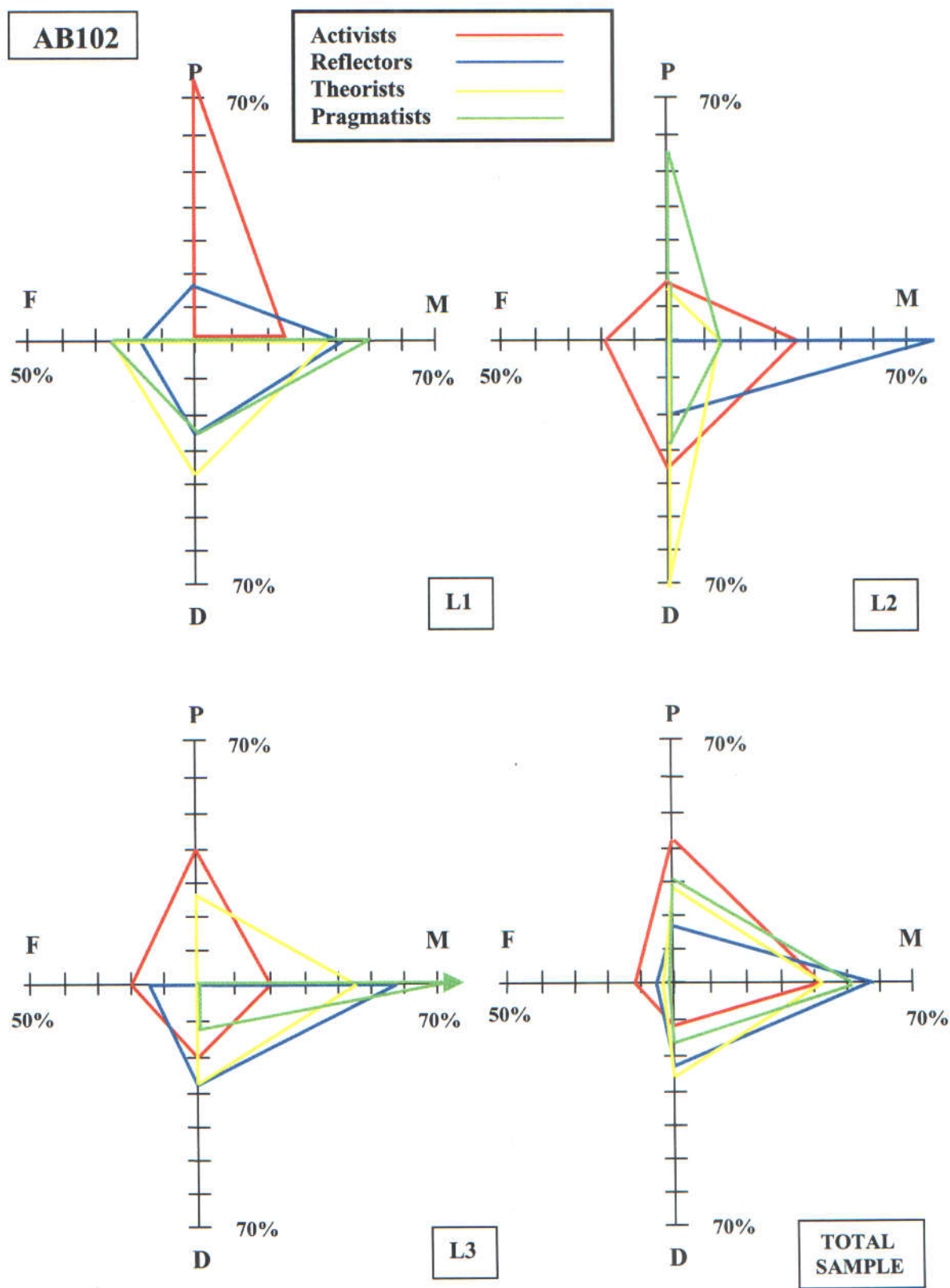


Figure 4.17

The activist group has again produced fewer distinctions than learners from the other three groups with no distinction grades at all at levels 1 and 3 and less than 10% at level 2.

AB602 (Engineering Science Assignment).

As in the case of AB598, the AB602 engineering science assignment (see figure 4.19 on page 141), shows no fails have been recorded at any level by any of the learning style groups. Unlike the AB598 assignment, AB602 involves a practical laboratory experiment which is written up by the learner in a scientific format and presented as a standard laboratory project. Again we may observe that activists at level 1 have recorded an abnormally high number of pass grades but no distinctions. Reflectors and theorists have both achieved a high number of merits and distinctions while the pragmatist profile alters slowly as we move through the levels until the level 3 profile is very similar to the general norm.

AB604 (Engineering Science Examination).

The profile for the AB604 end-phase engineering science exam is notable for several features which may be observed on the graphs which appear as figure 4.20 on page 142. At level 1 the activists have again failed to record any distinction grades while both the reflector and theorist groups show a high percentage of distinction grades on this assessment and no fails. The pragmatist group at level 1 have achieved merit grades in every case recorded. The level 1 graph possibly shows the biggest differences in performance pattern for any of the assessments under investigation across the four styles. This suggests that individual learning styles may play a bigger part in student performance on this type of assessment than on other types and this may be partly down to the types of knowledge that are tested during the AB604 examination. It is interesting to note how the activist performance pattern changes as we move from level 1 through to level 3. At level 2 the activist group shows a slight reduction in fail grades from the level 1 group and some of the merits recorded at level 1 have now become distinctions. At level 3 as the learning style preference becomes less significant there are no pass grades recorded but there is an increase in each of the other three grades.

Assessment Performance Patterns at Levels 1 - 3.

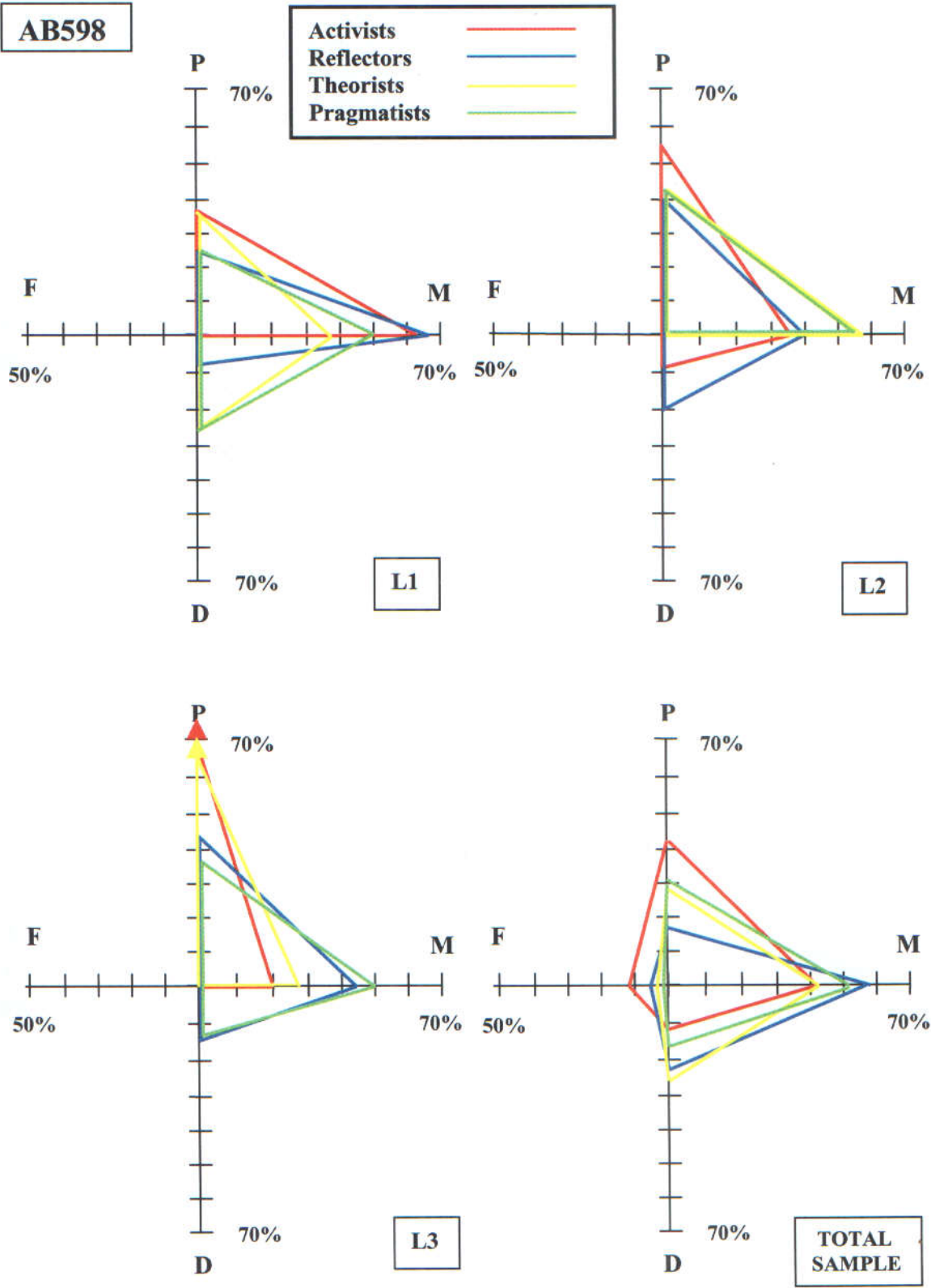


Figure 4.18

Assessment Performance Patterns at Levels 1 - 3.

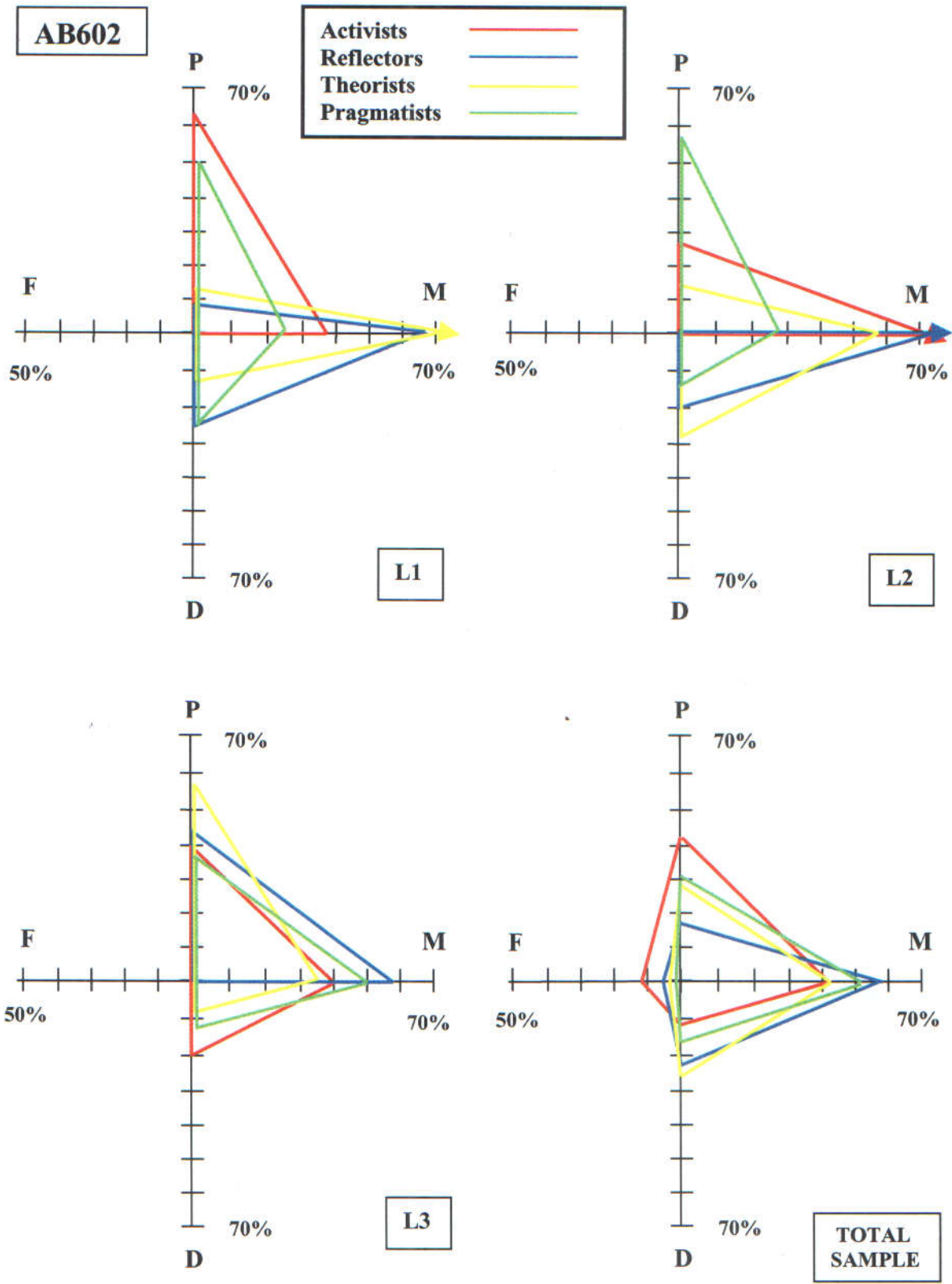


Figure 4.19

Assessment Performance Patterns at Levels 1 - 3.

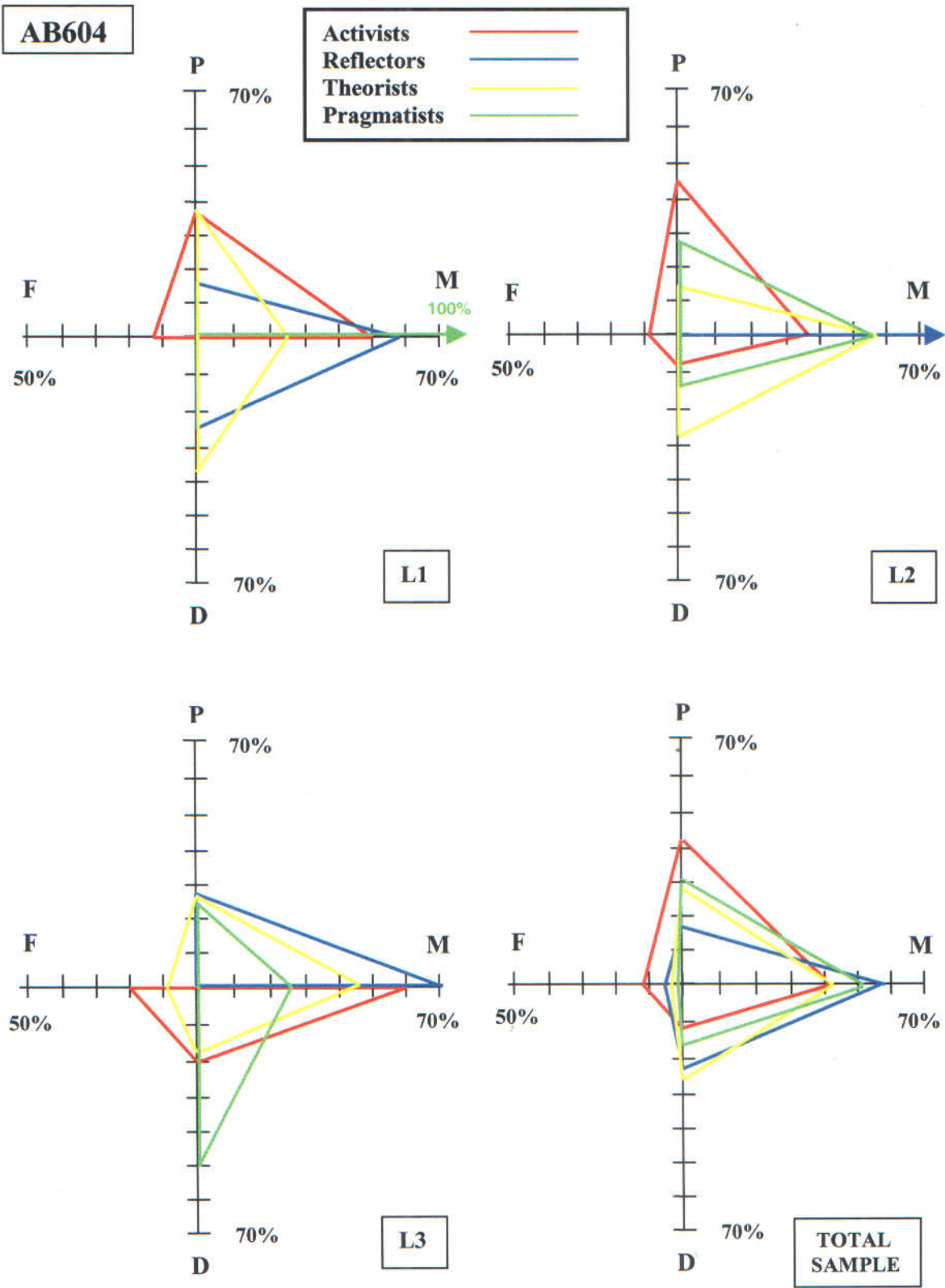


Figure 4.20

Assessment Performance Patterns for Learners in the 'Hub'.

There were 6 learners in the 'hub' out of the total sample of 100 students who were tested for this research. The grades awarded to the hub learners on each of the five assessments that formed the focus of this study are included as appendix (CC) at the rear of this report.

Analysis of the 'hub' results reveals that the performance pattern for this group of learners is very similar to that for the total sample of 100 students which includes learners from all learning style groups. This represents the general norm for the sample and the similarities may be observed on the profiles which are included as figure 4.21 overleaf. It is evident from the performance pattern profiles that the hub learners didn't record any fail grades for the five assessments which formed the focus of this study. This compares to a fail rate of 3% for the sample overall. The remainder of the profile is also within $\pm 3.9\%$ of the general norm showing a very similar profile in this case. Taking the analysis one step further, the table of results in the appendix does not reveal any significant differences in the results recorded for individual assessments. The grades seem evenly distributed across the five papers perhaps suggesting a degree of adaptability for this group of learners.

Performance Pattern for Hub Learners Across the Range of Assessments.

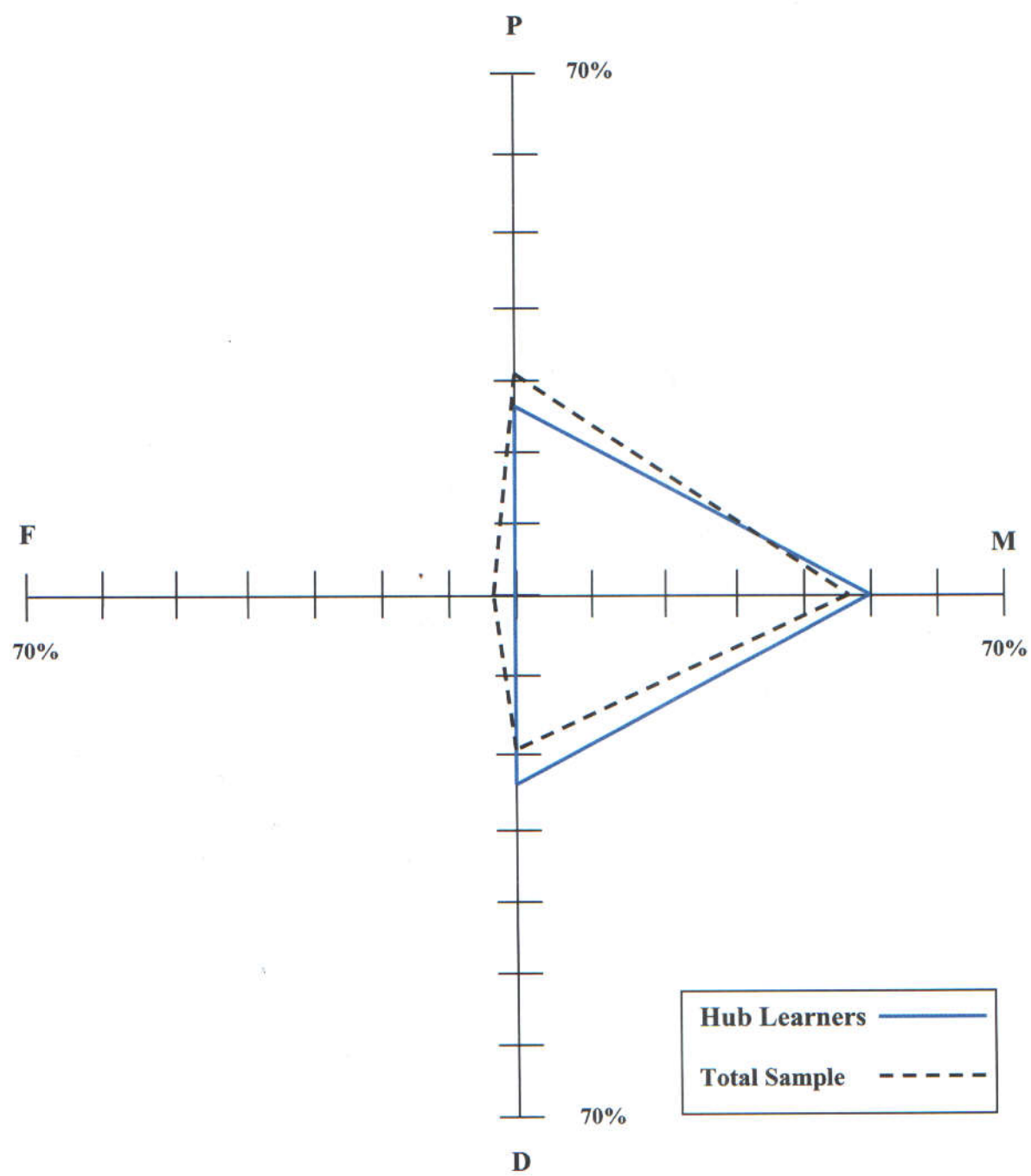


Figure 4.21

Strand 5 - What Types of Knowledge are being Tested during BTEC (NC) Summative Assessment at RAF Cosford?

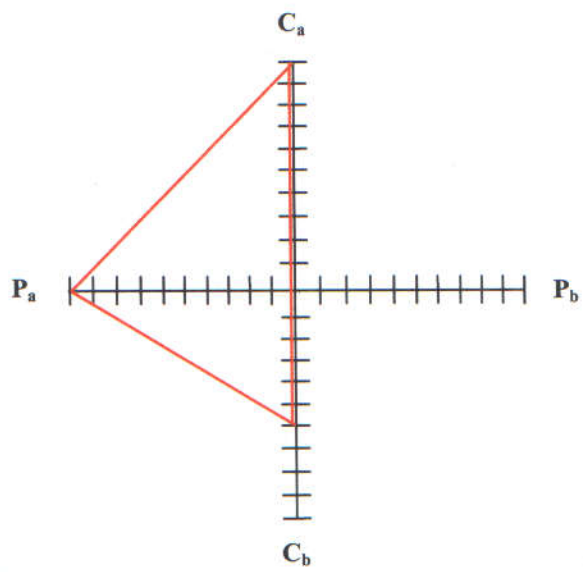
This strand of research involved a detailed analysis of the five assessment papers which formed the focus of this study. The criteria used during this documentary evaluation is included as appendix (L) at the rear of this report and the results recorded are included as figures 4.22 to 4.27 overleaf:

The results show that the types of knowledge tested by the assessment instruments varies considerably across the range with only AB604 (Engineering science exam) giving a balanced profile for level 'a' and 'b' concepts and procedures. The remaining four assessment instruments show a significant imbalance towards certain knowledge types, though overall (see figure 4.27) the balance is reasonable with a slight leaning towards conceptual knowledge at level 'b'.

AB598 (Materials science assignment) is a particularly interesting paper as it fails to test any conceptual or procedural knowledge at level 'a'. As the profile shows, level 'b' concepts and procedures are prevalent throughout the assignment. AB100 (Maths mid-phase exam), though not quite so extreme, shows a significant bias towards level 'a' concepts and procedures, while AB102 (Maths end-phase exam) and AB602 (Engineering science assignment) are almost a mirror image of each other with one biased towards level 'a' knowledge types and the other towards level 'b'.

ASSESSMENT PAPER N°: AB100 (Mid-phase mathematics examination).

Qu.N°.	C L _a	C L _b	P L _a	P L _b	Comments
1	✓		✓		Using calculator to solve equation.
2	✓		✓		Express 183470 to 2 sig.figs.
3	✓		✓		Covert $\frac{13}{20}$ to a %.
4	✓	✓	✓		Algebra/indices – simplify.
5	✓		✓		$\text{Log}_2 16 = x$ (Solve for x).
6	✓		✓		Evaluate $5.6e^2$.
7	✓	✓	✓		Conversion. (Metres to miles).
8	✓		✓		Convert 1010_2 to base 10.
9	✓	✓	✓		Solve linear equation.
10	✓	✓	✓		Transpose.
11	✓	✓	✓		Transpose.
12	✓	✓	✓		Written volume problem.
13	✓	✓	✓		Surface area problem.
14	✓	✓	✓		Mass & density problem.
15	✓	✓	✓		Trapezoidal rule.
16	✓	✓	✓		Find equation of straight line.
17	✓	✓	✓		Convert rpm to rads/s.
18	✓	✓	✓		Arc length/Pendulum length.
19	✓		✓		Cos curve trigonometric functions.
20	✓		✓		Trigonometry. (Solve triangle).
Totals (%)	100	60	100	0	



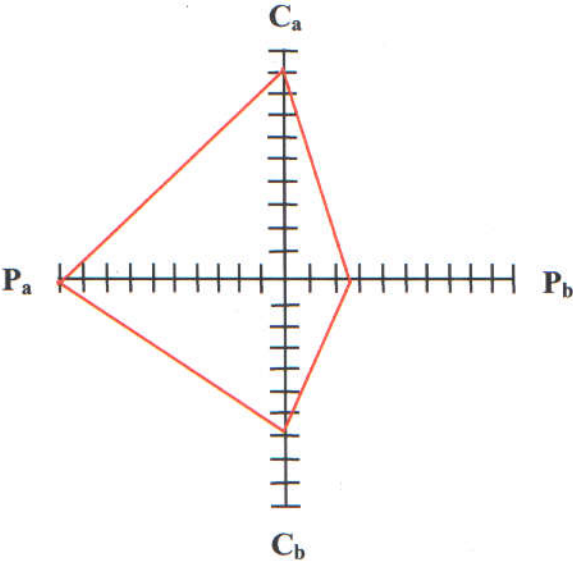
Overall Comments:

No level 'b' procedural knowledge tested by this paper. The vast majority of the questions test context specific/symbolic knowledge.

Figure 4.22

ASSESSMENT PAPER N°: AB102 (End-phase mathematics examination).

Qu.N°.	C L _a	C L _b	P L _a	P L _b	Comments
1			✓		Use Table - °C to °F.
2	✓	✓	✓		Proportionality.
3	✓		✓		Solve quadratic by formula.
4	✓	✓	✓		Solve linear simultaneous equations.
5	✓	✓	✓		Polar to rectangular.
6	✓	✓	✓		Differentiate algebraic functions.
7	✓	✓	✓		Moving particle question.
8	✓	✓	✓		Integrate algebraic functions.
9	✓	✓	✓	✓	Plot $y = e^x$ and find area.
10	✓		✓		Mean, median, standard deviation.
11	✓	✓	✓	✓	Analyse & investigate statistics.
12	✓		✓	✓	Graphical vectors.
13					
14					
15					
16					
17					
18					
19					
20					
Totals (%)	92	67	100	25	



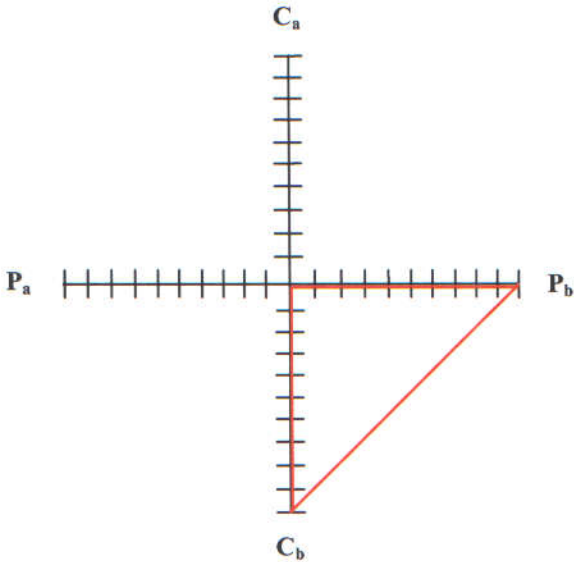
Overall Comments:

25% of the questions test student procedural knowledge at level 'b'. This is mainly where students have to plot or construct graphs/vectors. Normally these tasks are combined with CL_a and PL_b applications.

Figure 4.23

ASSESSMENT PAPER N°: AB598 (Materials science assignment).

Qu.N°.	C L _a	C L _b	P L _a	P L _b	Comments
1		✓		✓	Select and identify materials.
2		✓		✓	Investigate properties/suitability.
3		✓		✓	Suggest and analyse alternatives.
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
Totals (%)	0	100	0	100	



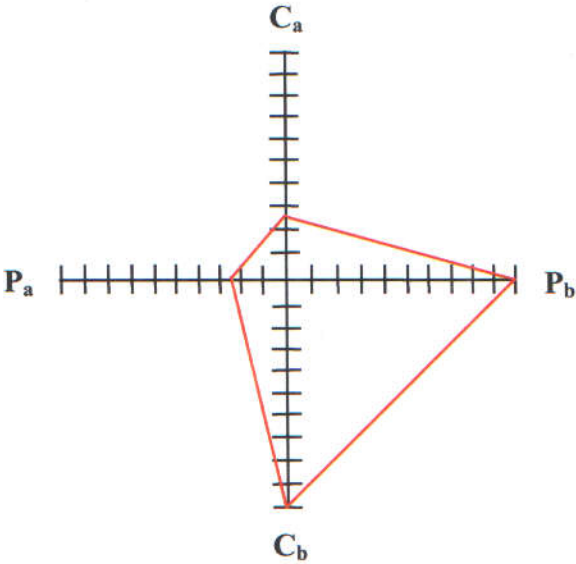
Overall Comments:

This is largely a written assignment requiring investigation and analysis at level ‘b’. There are no symbolic procedures or concepts inherent in this project.

Figure 4.24

ASSESSMENT PAPER N°: AB602 (Engineering science assignment).

Qu.N°.	C L _a	C L _b	P L _a	P L _b	Comments
1		✓		✓	Construct simple m/c in laboratory.
2	✓	✓	✓	✓	Use simple m/c to calculate MA, VR ...
3		✓		✓	Discuss results.
4		✓		✓	Conclusions.
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
Totals (%)	25	100	25	100	



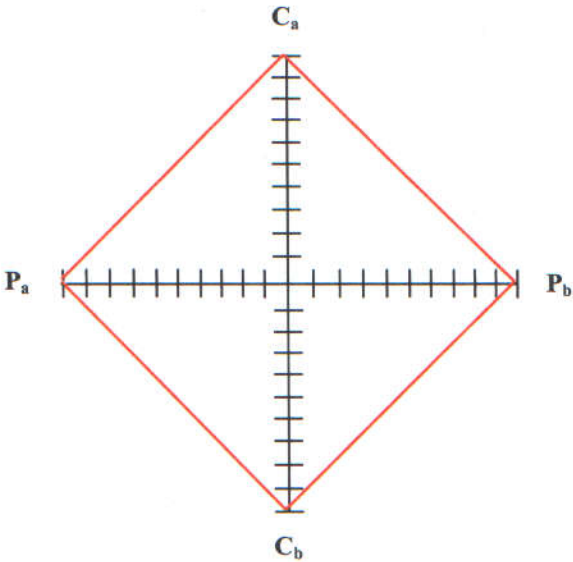
Overall Comments:

Symbolic concepts and procedures are only tested during part 2 of the assignment. The assignment overall thoroughly tests level 'b' concepts and procedures.

Figure 4.25

ASSESSMENT PAPER N°: AB604 (Engineering science examination).

Qu.N°.	C L _a	C L _b	P L _a	P L _b	Comments
1	✓	✓	✓	✓	Shear forces.
2	✓	✓	✓	✓	Friction.
3	✓	✓	✓	✓	Force & motion in a lift.
4	✓	✓	✓	✓	Aircraft carrier arrester hook.
5	✓	✓	✓	✓	Jet engine compressor blade.
6	✓	✓	✓	✓	Screwjack problems.
7	✓	✓	✓	✓	Rifle bullet velocity etc.
8	✓	✓	✓	✓	Aircraft fuel pump.
9	✓	✓	✓	✓	Aircraft tyre.
10	✓	✓	✓	✓	Aerofoil flows.
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
Totals (%)	100	100	100	100	



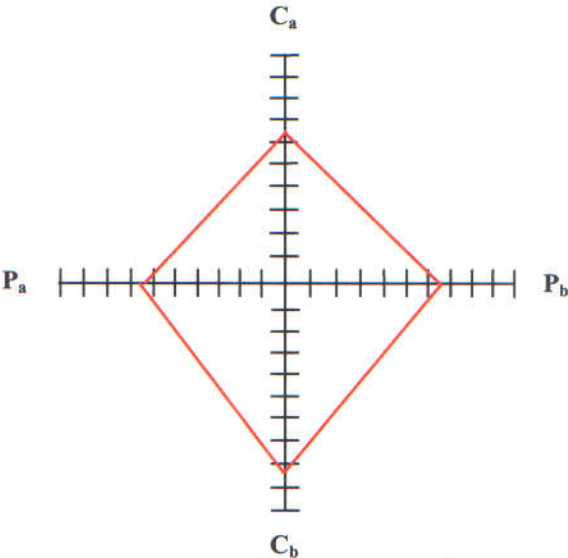
Overall Comments:

The nature of the questions on this exam leads to all types of knowledge being tested. Sketches and mental imaging form an integral part of each problem, which are all based upon applied mathematics.

Figure 4.26

OVERALL SUMMARY: Combined totals for five assessments.

Paper	C L _a	C L _b	P L _a	P L _b	Comments.
AB100	100	60	100	0	
AB102	92	67	100	25	
AB598	0	100	0	100	No level 'a' concepts or procedures tested.
AB602	25	100	25	100	
AB604	100	100	100	100	Perfect balance tested.
Totals:	317	427	325	325	



Overall Comments:

Taking the five assessments overall, the types of knowledge tested are reasonably well balanced, with a slight leaning towards conceptual knowledge at level 'b'. The individual papers, however, are very different from each other as shown by the scores above and should provide scope for evaluating the relative success or failure of different types of learner where the assessments are biased towards one type of knowledge or another.

AB598 is a particularly interesting paper as it only tests concepts and procedures at level 'b', whereas, AB604 appears to have a perfect balance with each question on the paper testing each of the knowledge types identified for this study.

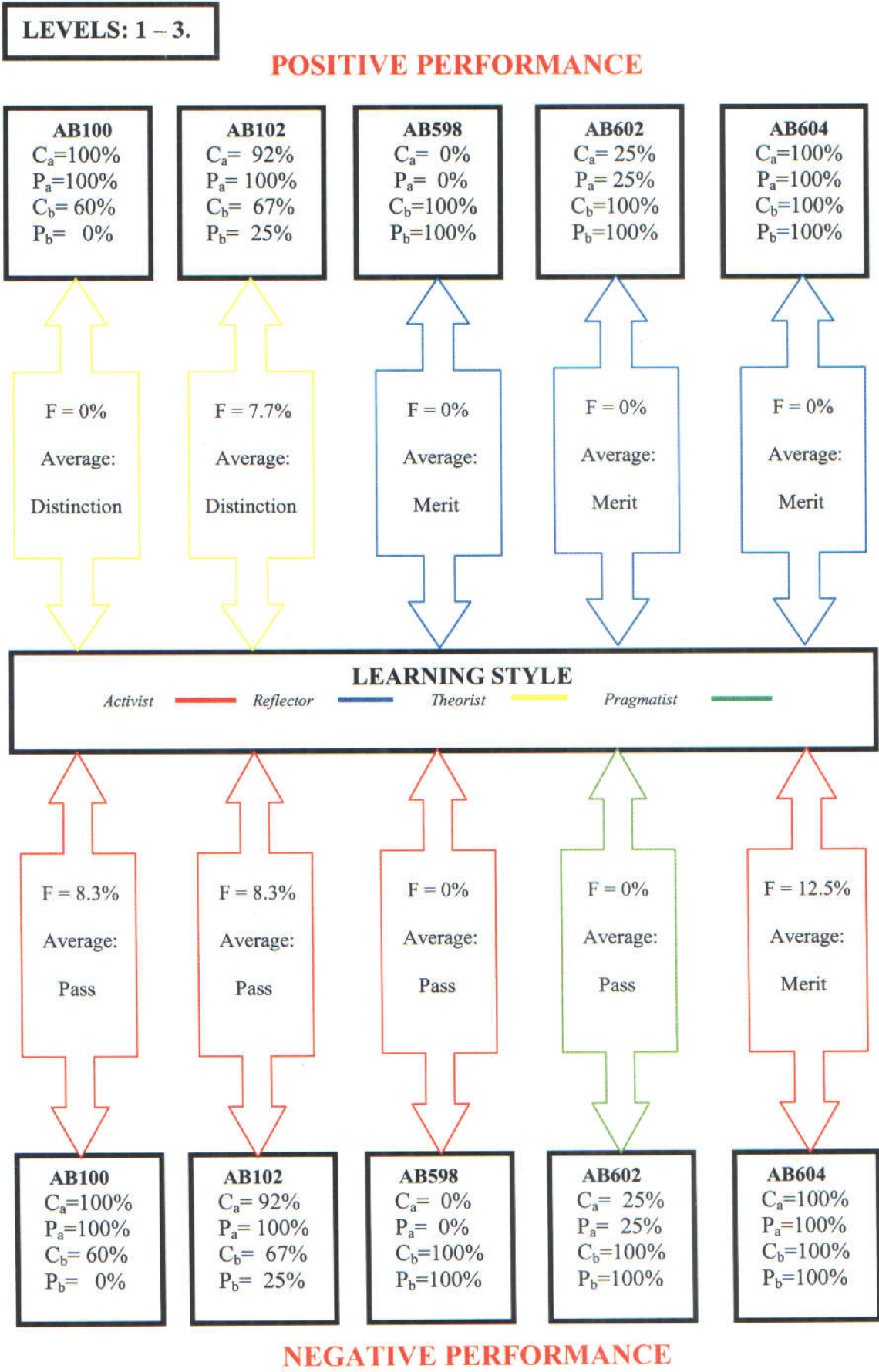
Figure 4.27

What is the Relationship between Assessment, Knowledge and Individual learning Styles at Levels 1 – 3 Combined.

Analysis of figure 4.28 that appears overleaf provides a summary of positive and negative performance profiles on the five assessment episodes that form the focus of this study. It is evident that in four of the five cases the activist (α) group of learners have been the worst performers based upon the modal grade achieved and the overall failure rate. On the remaining assessment (AB602), the pragmatist (ϵ) group display the worst set of results. On the positive side, the reflector (β) and theorist (δ) groups dominate the overall picture. Reflectors (β) have come out top in three of the five assessment episodes under investigation, while the theorist (δ) group show the best results on the remaining two.

From this set of findings, there is inadequate evidence to suggest that these extremes in performance have been influenced by the types of knowledge tested by each of the assessment instruments. We may, however, make several observations that warrant further discussion. The theorist (δ) group have come out top on the two mathematics examinations (AB100/AB102). If we look at the knowledge breakdown for these examinations, then in many respects they are very similar with a bias towards level 'b' concepts and procedures. As the knowledge emphasis shifts towards level 'b' concepts and procedures (AB598/AB602), the reflector (β) group take over as the best performers and indeed, they retain this position on AB604 where the evaluation criteria shows a perfect balance of knowledge across the assessment paper.

There is little doubt that based upon the evidence from this case, activist (α) learners are far less likely to succeed than learners with a preference for one of the other three styles. Apart from AB602 where the Pragmatist (ϵ) group were the worst performers, activist (α) learners show higher failure rates and lower average grades in each of the remaining four assessments. This reflects a 5.8% failure rate for activists overall, as opposed to 1.1% for pragmatists, 2.3% for theorists and 2.5% for reflectors. Activist learners also have the worst record for distinctions with just 10.8% overall, as opposed to 16.84% for pragmatists, 21.7% for reflectors and 26.2% for theorists.



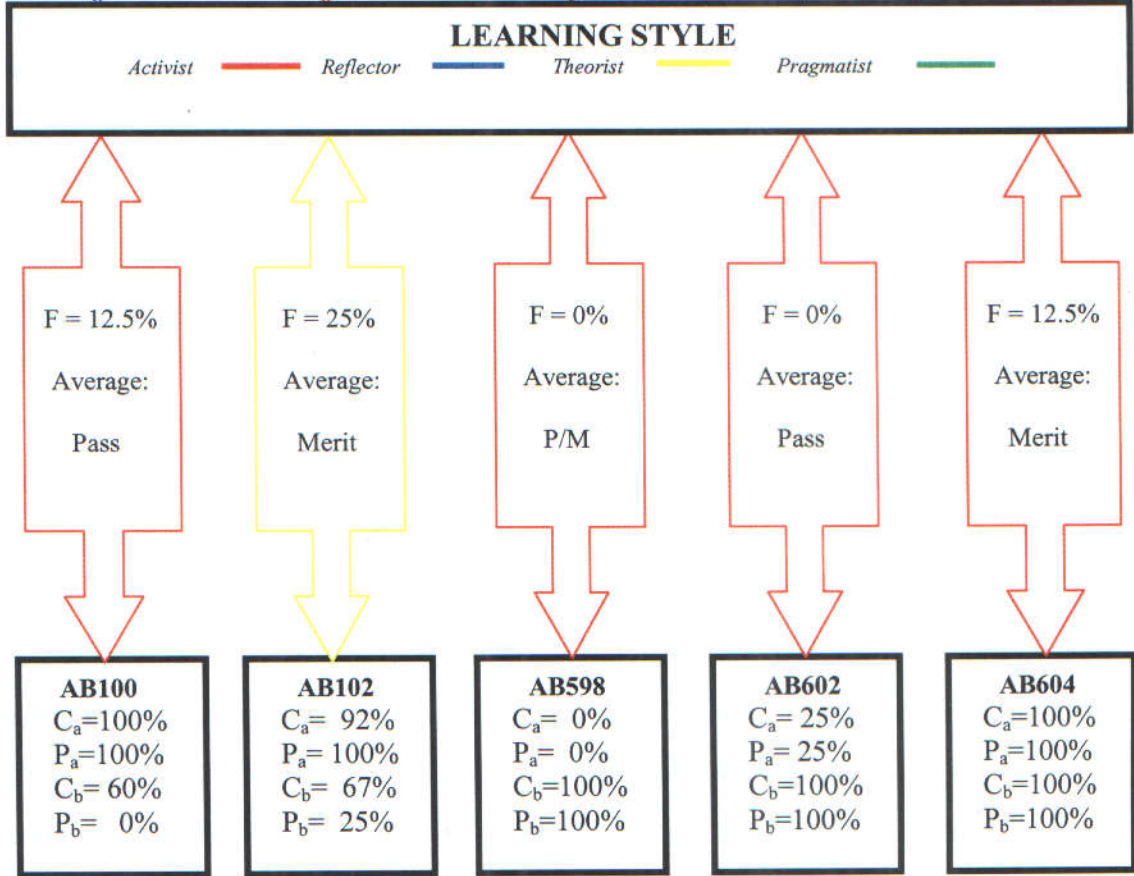
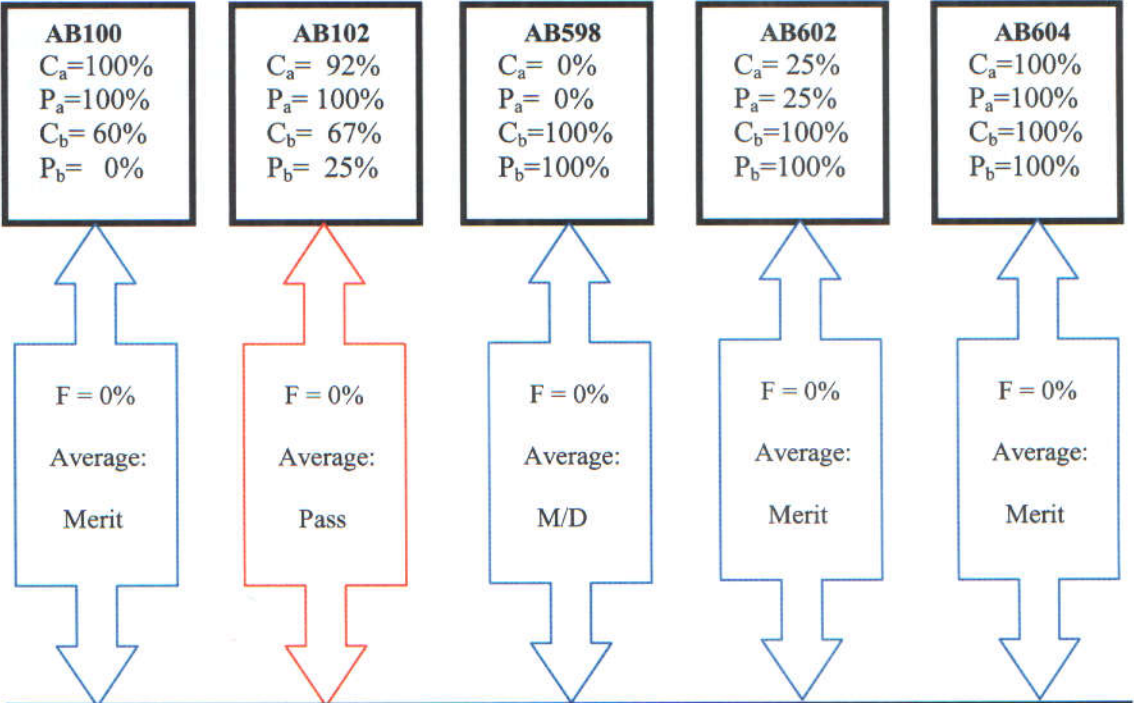
The Relationship between Assessment, Knowledge and Individual Learning Styles at Level 1.

If we focus on the level 1 learners, who represent the individuals with the most significant preference towards a particular learning style we find a similar pattern beginning to emerge. Analysis of figure 4.29 overleaf shows that the level 1 reflectors have been the best performers on four of the five assessments under investigation. Likewise, the level 1 activists have again attained the lowest modal grade and the highest failure rates on the same four assessments.

As in the case of levels 1 – 3 combined, there is inadequate evidence here to suggest that the breakdown of knowledge types for each assessment instrument has influenced this set of results. Nevertheless, we may again make several observations which warrant further discussion. The main anomaly in this case is AB102 where the activist group emerge as the best performers and the theorists as the worst. This is even more suprising if we consider that for AB102 overall, those roles are reversed with the theorists coming out on top and the activists in their usual position at the bottom. One further noteworthy point is that if we consider levels 1 – 3 in total, no learner, regardless of their individual learning style, has failed either of the assignments (AB598/AB602). All recorded failures within this study have occurred on the three formal examinations which make up the sample (AB100/AB102/AB604).

LEVEL 1.

POSITIVE PERFORMANCE



NEGATIVE PERFORMANCE

Figure 4.29

Chapter 5: Discussion and Recommendations.

Strand 1: What is the Nature of Assessment on BTEC (NC) Courses in Engineering Principles.

Strand 1 revealed a complex assessment strategy for each of the BTEC (NC) modules that I have described as 'dendritic' by nature due to their tree-like structure when formed into a flow diagram. If we compare the four flow diagrams (see figures 4.1 & 4.2 and appendices (R) and (S)) to the bi-polar constructs identified by Harris & Bell (1996 page 97), it seems that we have a reasonable balance of formal, informal and semi-formal procedures that test both product and process. The procedures used also have an inherent emphasis upon criterion referencing and exemplify the 'state' model described by Butterfield (1995). This simple model distinguishes between mastery and non-mastery, but does not provide criteria for grading beyond a 'pass'. Our system does likewise, though grades are awarded beyond pass level on the basis of the percentage mark attained by the student, a method that is seemingly detached from the assessment criteria. This point will be discussed during the strand 2 summary as it has implications for the validity of the scheme.

One of the most positive aspects of the assessment policy concerns the wide range of assessment instruments that are currently in use. The strategy overall has a good mix of assessment procedures including practical and written assignments, examinations and evidence based episodes for the purpose of grading and certification. Furthermore, if we compare the BTEC (NC) assessment strategy to the sixteen bi-polar constructs identified by Harris & Bell (1996 page 97), it is apparent that fifteen of the constructs are represented within the RAF Cosford scheme. The only construct not represented is norm referencing, a construct that contradicts BTEC policy as outlined in their current literature (See BTEC/EDEXEL 1998). The four flow diagrams that I assembled for each of the BTEC (NC) units under investigation may be evolved into a generic model for the assessment of the BTEC (NC) academic units. This is included as figure 5.1 overleaf.

THE DENDRITIC NATURE OF ASSESSMENT ON BTEC (NC)
ACADEMIC UNITS IN ENGINEERING PRINCIPLES.

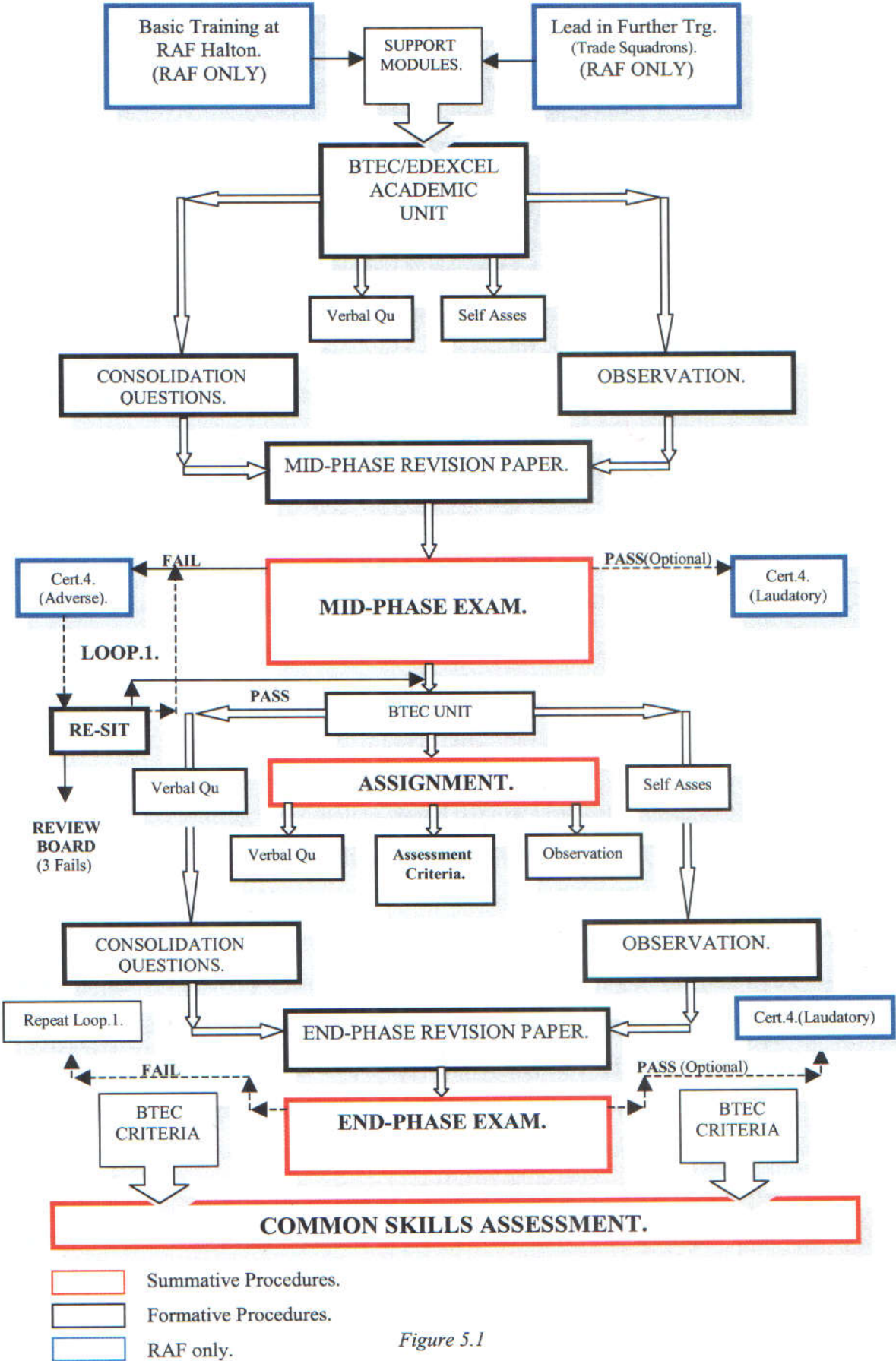


Figure 5.1

Strand 2: Does the Scheme have ‘Construct’ and ‘Content’ Validity.

Construct Validity.

Within my literature review, I accepted Harris & Bell’s definition of criterion referencing, which states that:

“Criterion referenced assessing aims to assess the learner by comparison with some pre-determined or negotiated criteria (e.g. A competency or a specified attainment target)”
(Harris.D. & Bell.C. 1996 page 101)

At RAF Cosford, rather than assessing against a specified attainment target, we assess learners against training and enabling objectives. The problem is, with the current System, our examinations and assignments fail to distinguish levels beyond a ‘pass’ other than to grade students attaining 65% to 84% with a ‘merit’ and 85%+ with a ‘distinction’. This means that a student who attains the minimum 50% pass mark for the assessment, can fail half the objectives tested by the paper, and yet still be awarded a pass grade for the unit overall. This, in my view, affects the ‘construct validity’ of the assessment as the test fails to measure what it purports to measure. In essence, we are actually awarding students a pass in objectives or outcomes that they may have failed.

One approach to reducing this problem would require a radical re-design of the summative assessment papers enabling each BTEC (NC) outcome, to be assessed as a separate entity. This would require ‘pass’, ‘merit’ and ‘distinction’ criteria to be drawn up for each outcome that is being assessed and would ultimately require students to show competence in every outcome rather than simply attaining a 50% pass mark overall. A system of this type would appear to satisfy BTEC/EDXCEL policy as outlined in their professional development and training notes (1998). Furthermore, it would enable the complete eradication of percentages, as each outcome would be mapped to specific criteria that the student must satisfy to attain a pass, or if necessary, to grade their performance beyond a pass. Students failing to reach the required standard in certain outcomes could be ‘referred’ and asked to re-sit single outcomes rather than a whole paper or assignment, as is the case under the current system. This, in my opinion, would not only provide a more rigorous form of assessment, it would

be fairer to the student and would ultimately lead to learners attaining competence in a greater breadth of the course content. An example of a question for the BTEC (NC) outcome 'calculus' is included as appendix (DD). The question shows my proposed new format broken down into pass, merit and distinction elements. It should be noted that elements included in the 'pass' section are fundamental to calculus work in general and students *must* show competence in these elements to attain a pass for the outcome. Work in the merit section is not academically harder, but reflects the grading criteria characteristics suggested by BTEC/EDEXCEL (1998) which are outlined on pages 13/14 of this report. In this case the merit elements go beyond 'the basic ideas' and require an element of 'adaptability'. The distinction elements continue this process requiring 'synthesis of concepts from other modules', 'evaluation' and 'consideration for alternatives'. Work at this level should also be coherent and well structured with appropriate use of technical language. This is in accordance with the BTEC quality update – issue 28 (July/August 1998). If for certain outcomes the level and depth of work covered is not found sufficient to include merit and distinction criteria, it is appropriate to assess at pass level only. These outcomes must still be passed to claim the BTEC (NC) unit, but will not contribute to a grade beyond pass level.

Although the recommendations outlined above will help to reduce the problems specified, they will not provide a solution to the related problems that were outlined on pages 92 - 97 of this report. Analysis in this area of research revealed that poor question design may result in up to six objectives being tested by a question that was originally designed to test one objective. This again has an adverse affect on construct validity as the test ultimately fails to measure what it purports to measure, an issue raised by Fletcher (1987) and reviewed earlier in this report. It also reduces content validity as some objectives tested by the offending questions test objectives that have already been assessed elsewhere. Poor question design is an important issue and this should be addressed during the re-design of papers in the suggested format.

Content Validity.

On the issue of 'content' validity, with the exception of the 'Pre-Technician Mathematics Test' (see page 100), the evidence from the mapping nomographs suggests that this aspect of validity is quite good. Virtually all the questions on the assessment

papers that make up the sample mapped directly to an objective in the syllabus. Even so, there is work to be done on weightings. By taking the analysis one step further and mapping marks allocated to an objective during summative assessment to the syllabus hours allocated to that same objective in the instructional specification, it became clear that only 50% of the objectives tested were weighted within $\pm 2\%$. The worst case showed an imbalance of 9.5% in favour of marks awarded during assessment, with three other cases showing a 6% discrepancy one way or the other. Problems of this type could again be rectified during the re-design of the assessment instruments into an outcome-based format.

Finally on the issue of content validity, Dawson & Thomas (1972) alerted us to problems associated with introducing student choice into summative assessment. They gave as an example the case where by offering students a choice of 5 questions from 9, we are actually introducing 126 combinations into the system, all of which have a different content. This has serious implications for the grading of students and for statistical analyses of student results. In essence, by introducing student choice into summative assessments, we are adversely affecting the content validity of the instruments and making comparability of performance difficult across the sample of candidates. My research revealed that although this problem is not widespread within our assessment scheme, it does exist in certain subject areas. I would claim, on the basis of this evidence, that this is an undesirable characteristic of assessment and should be avoided wherever possible.

Strand 3 – What Theories of Learning Underpin our Work within the Principles and Advanced Training Squadron (PATs).

There were three areas of research within strand 3, which revealed that the work of practitioners within the classroom did not always reflect the underpinning theory of learning depicted by the course documents. My initial approach was a documentary analysis of course materials that revealed an approach based entirely upon behavioural objectives, which could be broken down into a model similar to that described by Cegelka & Lewis (1983), and named by them as “applied behavioural analysis” (see page 32 of this report).

The model has certain characteristics that may be easily recognised, and the process begins with the identification of 'entry skills' and 'terminal behaviours' - information that is clearly stated within the instructional specifications that support all the academic modules at RAF Cosford. Once target behaviours are identified, in our case, in the form of 'training objectives', they are then broken down into what Cegelka & Lewis call 'sub-skills'. In our model, these sub-skills are what we call 'enabling objectives', and within the instructional specification these are clearly stated, as shown by the extract that was published on page 115 of this report. At this point Cegelka & Lewis state that each sub-skill requires a sub-programme. This takes us beyond the scope of the instructional specification and consequently into the second area of research for this section of my report. This involved non-participant observation of three lessons, delivered by three different lecturers, but with each delivering the same 'enabling objectives'. The aim in this area of research was to identify how each of the three lecturers within the sample developed a sub-programme to deliver each sub-skill and to discover whether the underpinning philosophy provided flexibility for lecturer autonomy in terms of instructional style. The findings revealed that each of the three lecturers observed approached instruction in their own unique way, and though each of them addressed the areas of presentation, practice and assessment identified by Cegelka & Lewis (see page 34 of this report), it became clear that there is sufficient flexibility within the model to allow for different instructional strategies. Though the sample was small, the fact that each of the lecturers observed approached instruction in their own way proved that there is scope for lecturer autonomy and that each has the flexibility to apply their preferred instructional technique in the classroom. One theory of learning that was plainly evident was what I would describe as Vygotskian social constructivism. This philosophy of teaching and learning was analysed by Roth (1999 page 11) and was reviewed earlier in this report. At the centre of the approach is the students 'zone of proximal development (ZPD)', and the instructional approach that I observed during my research displayed many characteristics of what Wood (1990) describes as 'contingency teaching' which is largely based upon accessing the students ZPD during the instructional process.

Also during this strand of research, I observed a 'student centred' approach which involved learners forming into self-help groups following a formal delivery by the

instructor. This approach probably still comes under the umbrella of ‘social constructivism’, but it is clearly different from the approach described above.

We may summarise this second phase of the sub-section by reference to the inherent flexibility it affords to the classroom practitioner. In three cases of non-participant observation carried out for the purposes of this study, I observed three different strategies for providing learners with ‘opportunities for practice’. Lecturer autonomy was at a premium with each of the three engaging in their own chosen strategy for helping learners to achieve their objective, yet still, the three lessons observed remained within the confines of Cegelka & Lewis’s model.

Moving on to the final stage of the sub-programme, assessment of mastery, again I observed three different approaches. These ranged from a formative text based consolidation exercise for lecturer ‘A’ to a formative ‘post test in the case of lecturer ‘B’. Lecturer ‘C’ had no formal assessment strategy but directed students to exercises in the text book and promised to re-visit the sub-skills taught during revision. This leads us back to the assessment flow diagrams that were published earlier in this report and effectively closes the loop in Cegelka & Lewis’s model by assessing mastery of the ‘terminal behaviours identified during the initial stage.

Finally, I moved onto the third area of research in strand 3 which probed for evidence of ‘experiential learning’ and which I reviewed on page 30 of this report. My study focused upon assignments, as these instruments are suggested by BTEC as a good vehicle for incorporating the experiential learning ethos into National Certificate courses. They also suggest design principles for this purpose (BTEC/EDEXCEL 1998). My analysis revealed that there is an emphasis on experiential learning during summative assignment work at RAF Cosford. Reference to figure 4.12 on page 125 of this report shows that for the sample of assignments tested, there was an overall score of 70% for experiential learning opportunities. Particularly strong in this aspect were laboratory assignments from the engineering science and electronics modules. Kolb (1984) alerted us to what he described as the ‘experiential learning cycle’ (see page 30 of this report), suggesting that such a learning cycle should include opportunities for planning, experimentation, reflection and conceptualisation. The engineering science and electronics assignments included in my sample provided opportunities for students

to engage with each of the above activities allowing them to complete the cycle within the framework of the assignment. Less strong in this area were the materials science assignments. Though they scored well on content validity, they were considered to be too prescriptive and left little scope for student experimentation and reflection. My recommendation in this case would be to re-design the assignments in a laboratory context whereby students could acquire 'hands on' experience of some of the materials and concepts under investigation, rather than the library book study that currently exists for this purpose. An example of a materials science assignment in the proposed experiential learning format is included as appendix (EE) at the rear of this report.

Analysis of appendix (EE) reveals opportunities for students to plan their work, experiment with their samples, reflect on results and conceptualise or re-conceptualise on the basis of their findings. The assignment also provides pass, merit and distinction elements to allow students to attain a grade beyond a pass where appropriate. Marking criteria would support each aspect of the assignment to increase the objectivity of the assessment though this is not included for the purposes of this explanation.

To summarise my findings from strand 3, it seems apparent that the basic model of instruction and learning operating at RAF Cosford fits neatly into the 'applied behavioural' system described by Cegelka and Lewis (1983). It is also apparent that during the instructional phase, lecturer autonomy is built into the model that allows individuals to engage with their own chosen philosophy of teaching and learning within the classroom. I found clear evidence of Vygotskian social constructivism and a 'student centred' form of social constructivism during this strand of research. I also found evidence of the 'experiential learning' ethos described by Kolb (1984). This complies with the BTEC/EDEXCEL philosophy that is outlined within their professional development and training notes (1998). The assessment of mastery is summarised by the flow diagrams that appeared earlier in this report (see figures 4.1 & 4.2) and which include all aspects of assessment including summative techniques for the purposes of grading and certification. I continue my strand 3 summary with figure 5.2 overleaf, which provides a diagrammatic account of the teaching and learning philosophy identified at RAF Cosford, and shows links with the Cegelka and Lewis model discussed previously.

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A Diagrammatic Summary of the Applied Behavioural Model Operating at RAF Cosford.

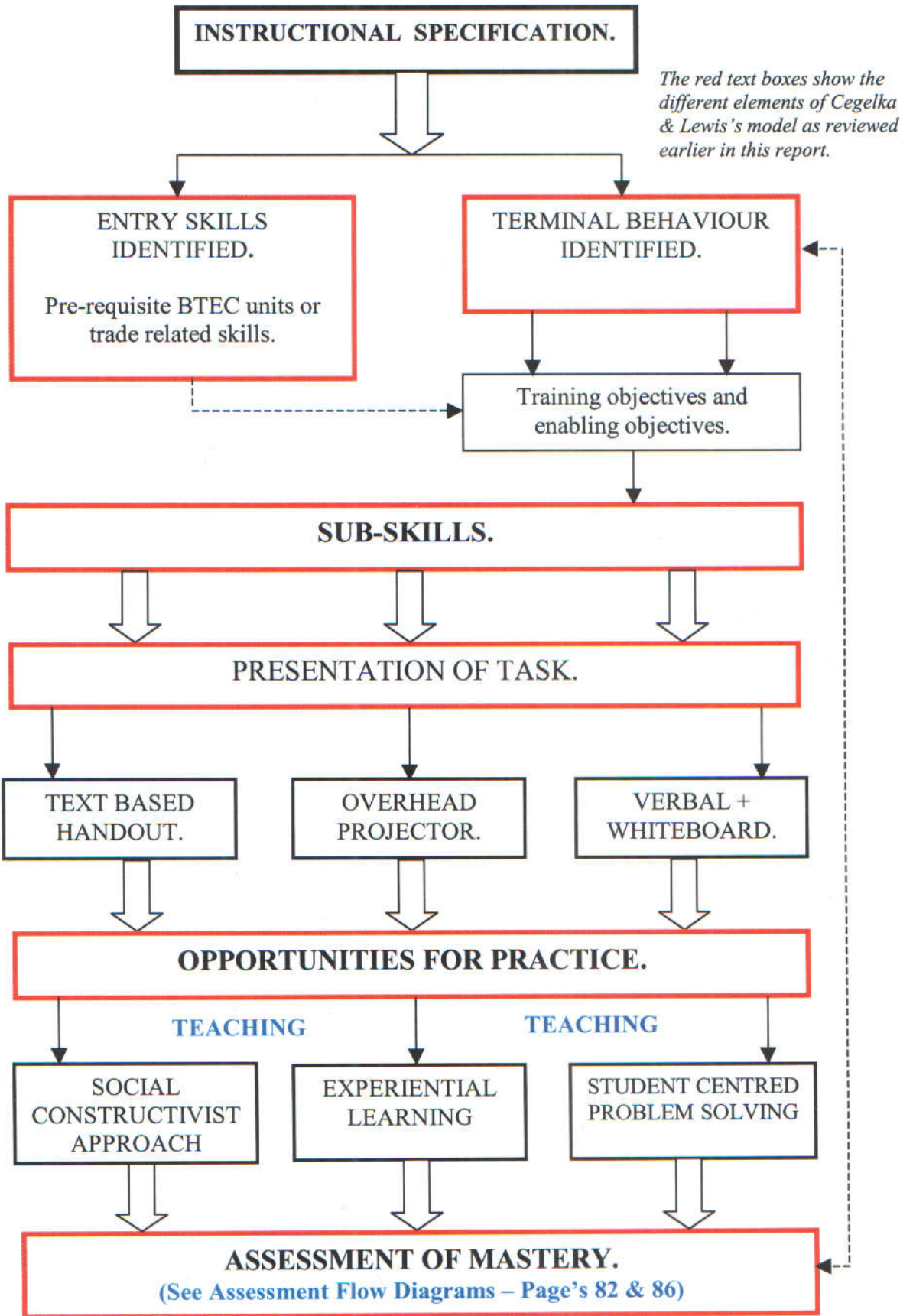


Figure 5.2

The Strand 3 Findings and their Impact on the Validity of the BTEC (NC) Assessment Strategy.

My strand 3 findings revealed an applied behavioural philosophy underpinning the BTEC (NC) units. Further research has also identified scope for lecturer autonomy regarding teaching strategies in the classroom. If I compare my strand 3 findings with the types of assessment included on figure 5.1, I may begin to theorise about some of the issues regarding the validity of the assessment scheme. We may loosely categorise the types of assessment that make up the scheme under three broad headings – (i) The summative assessment episodes that form the main ‘trunk’ of the scheme. (ii) The revision and consolidation papers that support the summative instruments, and; (iii) The formative episodes that are mainly designed and implemented by individual lecturers at classroom level. I have already paid considerable attention to examinations in an earlier part of this research. The instrument itself is summative and tutor judged. It mainly tests product and it is essentially an ‘end point’ test. Examinations tend to be a behavioural instrument as they test learners against behavioural objectives. Consequently, they complement the behavioural ethos that underpins the BTEC (NC) academic units and with the improvements I have suggested (appendix (DD)), form a valid instrument within the BTEC (NC) strategy.

I have also shown through systematic analysis, that the majority of summative assignments currently in use on the BTEC (NC) units, have as a feature, a satisfactory level of validity. BTEC (1998) suggest guidelines for assignment design that should result in an experiential learning encounter for the student. In 70% of the assignments sampled, opportunities for experiential learning were found to be at a high level. I have suggested improvements for the remaining 30% of assignments (see appendix (EE)), and if these changes are successfully implemented, it is my belief, that the validity of the assignments overall will be at an appropriate level. The remaining instruments in categories (ii) and (iii), rely for their validity on the individual lecturers who design them and the way they are utilised by practitioners in the classroom. The validity of these instruments is not subject to confirmation, or otherwise, through this piece of research. Construct validity asks the question – does the instrument measure what it purports to measure (Futcher 1987)? Verbal questioning, observation and the like, may be used to measure any number of variables in the classroom context, and

their use will depend largely upon the teaching strategy employed by individual lecturers. Revision and consolidation papers may also be used to support the different strategies employed by individual lecturers and may retain their validity in a variety of contexts. In summary, the wide range of assessment instruments that make up the BTEC (NC) strategy, in themselves, enhance the validity of the scheme. Many of the formative instruments will depend for construct validity on their 'fitness for purpose' (see Denvir 1989), and the responsibility for this falls firmly on the shoulders of individual practitioners within the classroom.

Strand 4 – What is the Relationship between Individual Learning Styles and the BTEC (NC) Assessment Strategy at RAF Cosford?

The findings from this strand of research produced some strong and consistent evidence and sowed the seeds for further research in the area of individual learning styles and their relationship with assessment. It became evident during strand 4, that the results attained by the activist group of learners were so far removed from those for the sample as a whole that there was a probability of less than one in a thousand ($p = <0.001$) that the results had occurred by chance. The reflector group also showed a significant probability rating with less than a two in a hundred chance ($p = <0.02$) that their results had occurred by chance. It seems appropriate to suggest, that in the case of each of these groups of learners' results had been influenced by some other factors. It was on this basis that I proposed that the individual learning style of the students in the activist and reflector groups was at least partly responsible for actual grades being so far removed from those expected on the basis of the sample norms.

My analysis progressed to carry out further chi-squared tests with learning style groups at different levels of significance. The results from this area of research showed that the level 1 activists and reflectors were largely responsible for the skewed results for those groups of learners overall. Based upon this evidence I would also make the evidential claim that the more significant the preference of the activist and reflective learners towards their particular style, the greater the impact on their performance in the five assessment episodes that form the focus of this study. This would seem to reflect the findings of Allison and Hayes (1988 & 1990) who reported that the LSQ was capable of distinguishing between groups of learners who could be expected to differ in their learning behaviour (see page 44 of this report). It is also evident if we

look at the results overall for these two groups, that as we move from level 1 through to level 3 the profiles become much more similar to those for the sample as a whole. This adds further credibility to my hypothesis that the individual learning style of the student has a significant effect on their performance during assessment. Furthermore, the results of this research seem to suggest that in the case of activists and reflectors, the greater the preference, the greater the impact on assessment results. The diagrammatic summary of assessment performance patterns at levels 1 to 3 that are included earlier in this report seem to support this view.

Having found evidence that the individual learning style of the student does impact upon assessment results, I began to focus upon each of the five assessments that form the focus of this study in an attempt to find out whether there were significant differences in performance across this range. I found further evidence to suggest that level 1 activists in particular, and level 1 reflectors to a lesser degree, are 'different' to other types of learner. The pattern of performance profiles for the mathematics examinations (AB100 & AB102 – see pages 136 and 138), show a very different profile for level 1 activists to the profile for other types of learner. Similarly, the reflector group reveal some unusual profiles at levels 1 and 2 particularly on AB102 and AB604 (see pages 138 and 142).

Finally in strand 4, I turned to the 'hub' learners, or learners with a modulus of < 2 , which indicates a very low preference for any of the four individual learning styles. My hypothesis was that these learners might prove to be very adaptable, as it is possible that they are able to adopt an appropriate style for any task in hand. This reflects the views of Nulty & Barrett (1996 page 342) who report that students in the latter year of a higher education course were able to adapt their learning style to match different disciplines. In other words, during a course of study, their claim suggests that students had moved towards the 'hub' and become more adaptable learners. Their work seems to provide a good example of a transitional effect that would lend itself to a study of 'causality' as described by Hage.J. & Meeker.B.F. (1988). They investigate the idea of causality and make a distinction between state and process variables in a causal process (page 76). If we are to help our learners on BTEC (NC) courses to move inwards towards the 'hub', then it seems sensible to suggest that a study of the variables that may 'cause' such an effect would be a significant step forward. There is

evidence in my research to suggest that some of the effects of assessment identified may help such a study to progress. This issue will be expanded further during the discussion of my strand 5 findings, as some causal effects were apparent within this area of research.

Further results from my research revealed that overall the performance profile for the 'hubs' was within $\pm 3.9\%$ of that for the total sample at all points. The most significant difference was that out of 30 grades, there were no fails recorded for any of the five assessments under investigation, as opposed to a fail rate of approximately 3% for the sample as a whole. I am not able to draw any concrete conclusions from this, as out of the total sample of 100 students just 6 were identified as 'hub' learners. Even so, it would seem appropriate to recommend that this is an area requiring further research.

The Relationship between Individual Learning Styles and the Validity of Assessment on BTEC (NC) Courses at RAF Cosford.

If, as my findings suggest, the performance of individual learners during assessment is influenced by their learning style, then it seems reasonable to suggest that this has implications for the validity of the assessment scheme. A summary of results across the five assessment episodes that form the focus of this study (see page 153), would seem to indicate that those learners with a significant preference for the activist style of learning perform less well than their counterparts in the other three groups. Overall, they have been awarded less merits and distinctions and have the highest failure rate with a modal average of a 'pass' grade across the board. On the other hand, the evidence suggests that the reflector group have been advantaged by the current system. This group has attained a modal average of a 'merit' grade while also scoring well on distinctions and recording no 'fail' grades on four of the five assessments under investigation. Perhaps this should be no surprise, as if we refer to Honey & Mumfords manual of learning styles (1986 page 26) they predict that activist learners may "react against" activities where:

"They are required to assimilate, analyse and interpret lots of 'messy' data."

(Honey.P. & Mumford.A. 1986 page 26)

This statement would seem to describe some of the academic work involved in science and mathematics where experimental data is often confused and disordered. Activists like to be involved with other people, “bouncing ideas off them and solving problems as part of a team” (ibid 1986 page 26). The type of assessments sampled in this study mainly involves isolated work under examination conditions and, if we accept Honey & Mumford’s depiction, would not suit the activist learner. Similarly, Honey & Mumford’s review of the reflector group predicts that these learners would perform well under the types of assessment sampled during this research. They refer to situations that require “assimilation”, “investigation”, “painstaking research”, “considered analyses” and the “opportunity to review” as those suited to this type of learner (ibid 1986 page 26).

The chi-squared tests for these learning style groups suggest that these results are unlikely to have occurred by chance and if I return to my original review of validity, it raises several issues that are pertinent to this area of research. Denvir (1989 page 277) alerted us to several issues when her work was reviewed earlier in this report. She acknowledged the relationship between validity and assessment purpose, and brought to our attention the links between different types of assessment instrument and the learning experiences of students. The authors of ‘Better Schools’ (1985) raise further important issues. They state that – “testing procedures should be used which minimise potentially damaging side effects” (page 51), and Futch (1987) writes about the ‘theoretical basis’ of assessment suggesting that if an assessment is not an accurate measure of a task or skill, then it is invalid for the purpose concerned. So how can a test be a valid measure of mathematical or scientific ability if certain students are disadvantaged due to their individual learning style? If the purpose of the assessment is to determine which students have achieved a standard in a particular outcome, and the result of the assessment is ‘skewed’ due to the individual learning style of the student, then surely, the assessment is unreliable on the grounds that students are experiencing the ‘same’ test item in different ways. As we have seen from the evidence in this research, this may affect how difficult a test item is for certain types of learner, thus leading to some learners being disadvantaged by the test. As an unreliable assessment cannot be valid (see E819 S.G. page 92), this reduces the validity of the assessment scheme overall, and in my opinion, is an issue that should be considered during the design of an assessment instrument. We can only begin to

confront such problems if we can first identify which types of assessment instrument either advantage or disadvantage the four learning style groups. This piece of research has made a start in achieving this aim but requires considerable expansion if it is to be used for this purpose. What I have identified here is evidence that the individual learning style of the student does influence performance during assessment and at the moment this influence is not considered during the design of assessment schemes for BTEC (NC) qualifications. The final strand of my research began to probe more deeply by investigating whether the types of knowledge tested during assessment could be linked to assessment performance by students within each of the learning style groups.

Strand 5 – The Relationship between Assessment, Knowledge and Individual Learning Styles.

My evaluation study into the types of knowledge tested by the five assessment episodes that form the focus of this study, revealed a reasonable balance of conceptual and procedural knowledge across the range of assessment instruments. At an individual level, however, the study revealed significant differences between each paper and provided scope for further investigation of the links between individual learning styles and assessment performance. Analysis of the materials science assignment (AB598) revealed that only level 'b' concepts and procedures were tested during assessment. This is significant, as the performance pattern profiles for this assignment show firstly, that no students failed the assignment, and secondly, that differences between the assessment performance profiles for the different learning style groups are not so apparent as in the other four cases. It would seem that the individual learning style of the student does not exert such an influence where level 'b' concepts and procedures are concerned. This effect may possibly be influenced by the distinction to which Barnes (1988) alerted us, between "educational knowledge and knowledge for action". Assignments at RAF Cosford tend by their nature, to be more relevant to the eventual work of the trainee than perhaps, examinations, which test theoretical concepts and the procedures that support them. André (1986) also made a distinction here, distinguishing between "declarative" and "procedural" knowledge forms, or as he puts it – "knowing that" and "knowing how". Assignments may fall primarily into the "knowing how" category, and help to bring the different learning style groups, particularly in this case activists and reflectors, closer together in terms of assessment grades.

The engineering science examination (AB604) provides further key evidence as the paper is perfectly balanced in terms of the knowledge tested by each question. It is evident from the performance pattern profiles in this case, that there are considerable differences in performance by each of the four learning style groups. The performance of the reflector group is particularly noteworthy if we observe the changing profile as we move through the levels. At level 1, the learners with the most significant preference for the reflector style recorded a very low number of pass grades with the majority attaining merits and a large number of distinctions. At level 2, every reflector who sat the paper was awarded a merit grade and as the learning style preference diminished further at level 3, we have a mixture of pass and merit grades with no distinctions. There were no fail grades recorded by reflectors at any of the levels of significance. The activist group is equally significant. The level 1 profile shows a mixture of pass, merit and fail grades, while at level 2 some of the merits appear to have been converted to distinctions. The level 2 profile is almost identical to that for the activist sample as a whole. At level 3 as the preference for the activist style diminishes, we almost have a mirror image of the level 1 profile.

Finally, analysis of the profiles for the mid and end-phase mathematics examinations (AB100 & AB102) reveals further convincing evidence. Analysis of knowledge types tested by AB100 shows that all questions included on the paper test concepts and procedures at level 'a'. 60% of questions test level 'b' concepts, but no level 'b' procedures are tested during the assessment. AB102 is similar, though in this case 25% of the questions test level 'b' procedures. These were mainly questions where students had to construct graphs or work graphically with vectors. The inclusion of 25% level 'b' procedures seems to have had quite a significant effect on performance across the different style groups. For example if we examine the positive and negative performance profiles for levels 1 – 3 combined (figure 4.28) and level 1 (figure 4.29) we appear to almost have a reversal in fortunes between different learning style groups. At levels 1 – 3 combined the activist group have been revealed as the worst performers on each of the examinations in question, at level 1, however, they have the worst performance profile on AB100 but the best performance on AB102. Level 1 theorists have recorded the worst performance on AB102 while scoring the best grades on levels 1 – 3 combined. Further evidence that the level 1 learners are influenced

more than their counterparts with lower preference levels by the types of knowledge tested during assessment.

So what may we conclude about the relationship between assessment, knowledge and individual learning styles? It is true to say that the evidence presented here is not conclusive. Even so, there is enough to suggest that further research, including 'item analysis', is necessary if we are to establish which types of learner are most likely to succeed, or indeed fail, when different types of knowledge are being assessed. My own view, based upon the evidence from this research, is that across the range of knowledge types as a whole, activist learners are less adaptable and consequently less likely to be successful. Reflectors, particularly those with a significant preference towards the reflector style are more likely to be successful and seem to be able to adapt more easily to tackle problems where different knowledge types are being tested. It is also evident from this sample that activist learners do not perform well when 'time constraints' are applied. This seems to be the case regardless of the types of knowledge being tested as is evident from the performance pattern profiles for the three formal examinations (AB100, AB102 and AB604). With the exception of the level 1 activists on AB102, an anomaly for which I offer no explanation, the number of fail grades awarded to activists are much higher than for other learning style groups. This contrasts with the performance profiles for the materials and engineering science assignments where no fail grades are recorded by the activist group, even though they are still the worst performers on these assignments in terms of the overall grades awarded to each group. This reflects the findings of Allison and Hayes (1988 page 278) who questioned the 'predictive validity' of the LSQ after their research revealed that learners who scored high marks on the action dimension did not necessarily gain the highest project marks. The removal of the formal time constraint and the nature of these assessments seems to have had a positive effect on the activist performance and this, to varying degrees, is replicated by results from other learning style groups. It is here that I would like to return to the issue of causality. If, as it appears, the performance of all learners has been enhanced by the use of assignments and the apparent differences in performance by the contrasting learning style groups has been reduced. The removal of the formal time constraint seems to have enabled learners to adapt their individual style much more effectively to the task in hand. If, one of our aims during a BTEC (NC) course of study is to help learners to move towards the

‘hub’ of the learning style graph and increase their adaptability, then there is evidence to suggest that replacing formal examinations by assignments would be a move in the right direction. This may explain the findings of Nulty & Barrett (1996), as the trend in higher education appears to have been a shift of this type during recent years with an increase in summative assignments and a reduction in formal examinations. Such a move would also increase the validity of the assessment scheme overall, as on the evidence of my study, it would almost certainly reduce the “potentially damaging side effects” that were of concern to the authors of ‘better schools’ (1985) and which were reviewed earlier in this report.

Chapter 6: Summary and Classification of Recommendations & Implications arising from this Study.

A number of recommendations and implications arising from this study have been outlined in the preceding sections of this report. It will be beneficial to readers if these are now summarised and arranged into a pyramid structure for the purposes of clarification. Some additional recommendations are also made in this section of the report.

I may define a number of levels that make up the structure of the pyramid and at which the various recommendations and implications of this study exist. At the highest level, and thus, at the apex of the pyramid are those recommendations and implications that effect assessment at international level¹⁰. Arising from this study I would identify the implications of strand 4 as existing at this level, as there is compelling evidence to suggest that assessment performance is strongly influenced by the individual learning style of the student. As a consequence, certain types of learner are advantaged and others disadvantaged by particular types of assessment procedure. This in turn has implications for the reliability and validity of assessment but currently, is not an issue that is widely considered during assessment design.

The issues under consideration also filter down to the next level of the pyramid, which concerns national implications. The Qualifications and Curriculum Authority (QCA) are currently designing the National Qualifications Framework (NQF). In October 1999 they commissioned the ‘Centre for Developing and Evaluating Lifelong Learning’ (cdell) to undertake an investigation into ‘Fair Assessment in Vocationally Related Qualifications

¹⁰ It should be noted that this study has not focused on differences between cultures, nationalities or ethnic groups, hence, the evidence does not support generalisations on this basis.

and NVQs. The report was published in March 2000. The study includes a review of recent literature on 'fair assessment' and focuses as part of this section on the issue of 'impartiality'. The authors distinguish between direct discrimination against groups defined by race, colour and creed etc; and indirect discrimination. The latter occurs they state:

“When the rules and conditions do not themselves discriminate but, in practice, a particular group is significantly disadvantaged because of an inability to comply.”

(cdell 2000. para 3.2.3)

There is strong and credible evidence within my research to suggest that 'activist' learners belong to a group who fall into this category. If further research can lead to generalisation of these findings, then there is a need for action at national level if 'fair assessment' is to be achieved. This would be an issue for BTEC/EDXCEL and other awarding bodies involved with the accreditation of national awards. The cdell (2000) report goes onto state:

“As a general rule, significant assessment disadvantage may be said to have occurred if the proportion of candidates from a minority group achieving a given level is less than $\frac{4}{5}$ of the proportion of candidates achieving the same level from the majority group.”

(cdell 2000. Para.3.2.3)

This takes me to the next level of the pyramid structure as it has implications at institutional level. The statistics from my research show that at certain levels of significance, activists fail to reach the $\frac{4}{5}$ threshold in several of the assessments that form the focus of this study. It is true to say that other factors may also have an influence here, as this study does not take into account the issues of gender, ethnicity, social class or similar considerations. Nonetheless, on the basis of the evidence from this research there are a number of recommendations that I would suggest for reducing this problem and thus increasing the validity of the assessment scheme. There is strong evidence that differences in assessment performance between the learning style groups are less apparent when summative assessment is carried out through assignment, rather than by formal examination. At institutional level, I would recommend an immediate shift towards assignments as the primary means of summative assessment. To help support this policy, I would further recommend that all students have their individual learning style assessed at the outset of their course, and that relevant statistics

regarding assessment performance are monitored so that the “ $\frac{4}{5}$ rule” may be applied. This would enable the performance of each individual style group to be compared to that of the remaining majority group, and action¹¹ taken wherever necessary to ensure that indirect discrimination does not occur.

These recommendations may be followed up at departmental level, which effectively takes me to the next level in the pyramid structure. My recommendations at this level are largely concerned with the ‘design’ of assessment instruments. While recognising that there may be a requirement to retain examinations in certain subject areas, my proposal is that all summative assessment instruments are designed in an outcome based format and that each outcome is supported by both assessment and grading criteria to provide five distinct bands. These would be Pass (P), Merit (M) and Distinction (D) for learners who attained a satisfactory standard in a specific outcome, and either a Referral (R) or Fail (F) for those falling short of the required standard on a particular occasion. In order to be credited with a BTEC unit towards their national certificate (NC), learners would need to attain at least a ‘pass’ grade in each and every outcome making up the unit before an award could be made. This system would allow for the complete eradication of percentage marks in favour of the P, M, D, R, F format and would ensure that students demonstrate competence in all outcomes, rather than simply attaining a pass on the basis of a 50% score as under the present system. An example of an examination question for the BTEC (NC) outcome ‘calculus’, designed in the suggested format, is included as appendix (DD) at the rear of this report.

Whereas the above recommendations relate to all summative assessment instruments, further recommendations concern the design of new assignments, which I suggest should have an inherent emphasis upon ‘experiential learning’. Research within strand 3 of this study revealed that 70% of the assignments sampled offer opportunities for experiential learning. By ensuring that all new assignments are designed with an experiential learning element, we will be reducing the problem of indirect discrimination defined earlier, as the ‘experiential learning cycle’ (Kolb 1976) accommodates learners of all learning style preferences as the assignment progresses to a conclusion. It may also help learners with a significant preference towards a particular learning style to become more adaptable and move towards the hub of the learning styles graph, as it will ensure that they engage with tasks that promote the

¹¹ This may include the withdrawal of assessment instruments where the ‘ $\frac{4}{5}$ rule’ is violated.

complete cycle of skills during the course of a project. An example of an assignment in my proposed new format is included as appendix (EE) at the rear of this report.

Finally, Dawson & Thomas (1972) reminded us of the consequences of ‘student choice’ within summative assessment and the implications for ‘content validity’. My recommendation on this issue is that student choice should be avoided wherever possible as any statistical analyses or comparisons between student performance would be rendered meaningless for the purposes of evaluation. This is particularly important if statistical evidence is to be used as the main tool to evaluate ‘indirect discrimination’ as recommended above. Students progressing towards a BTEC (NC) should each sample the same content during a summative assessment procedure. This will ensure that each assessment instrument provides a reliable measure of student performance and delivers valid statistical evidence for the purposes of evaluation. A diagrammatic summary of my recommendations at each level in the structure is included as figure 5.3 below:

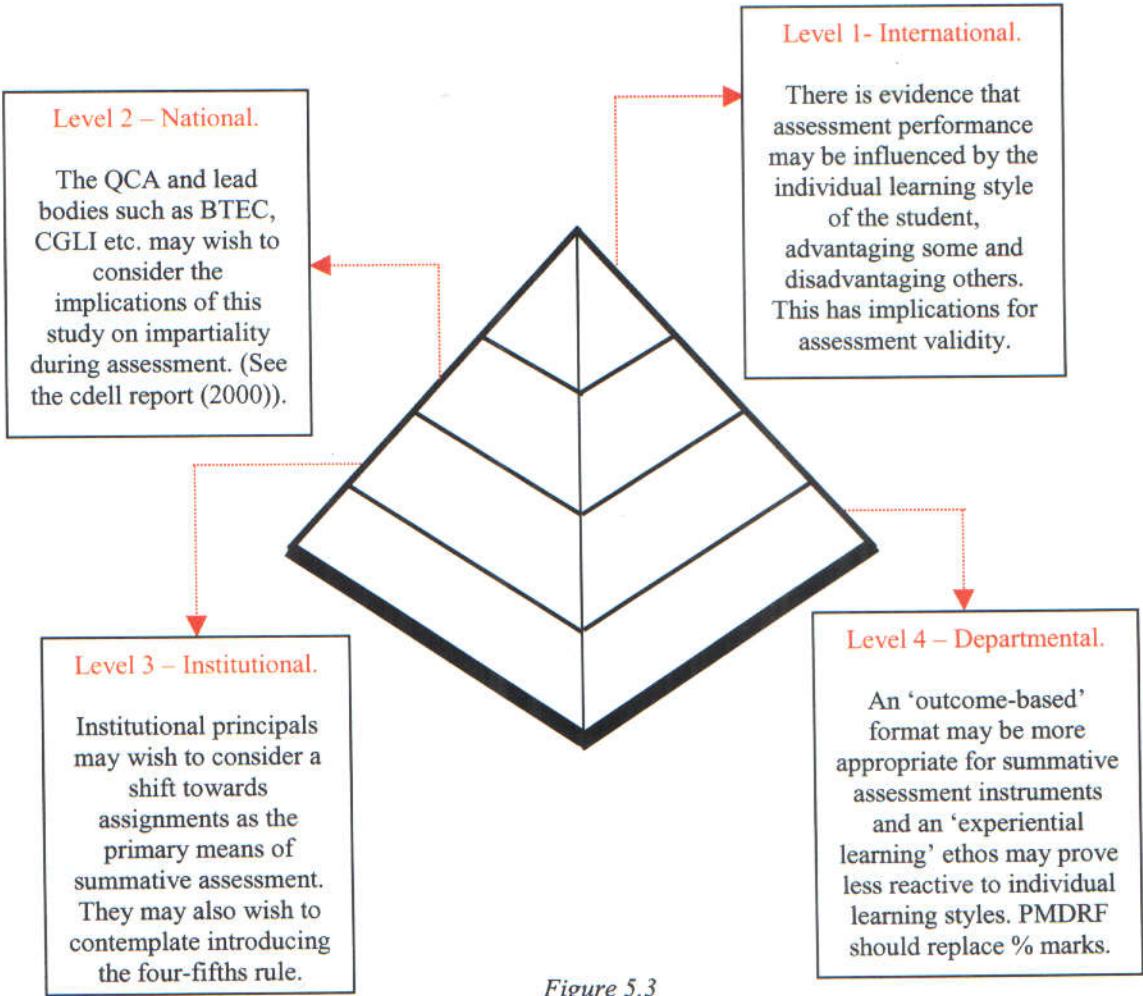


Figure 5.3

Chapter 7: Claims and Conclusions – A Closing Statement.

Overall, this research study reveals a number of positive aspects relating to the assessment of the BTEC (NC) academic modules. The breadth and range of assessment episodes revealed during strand 1, and the reasonably high level of construct and content validity revealed during strand 2 are two commendable aspects of the scheme. Even so, there are areas for improvement. The re-design of the summative assessment instruments into a more acceptable form of criterion referencing along with more focused questioning are two measures that will lead to a significant change for the better. I have also suggested a greater emphasis on experiential learning as part of this re-design process. In the long term, further research should be carried out to clarify the effects of individual learning styles during assessment. The evidence I have presented strongly suggests that there is a link between individual learning styles and assessment performance, and it is significant. Though it should be acknowledged that in certain contexts learners with a particular learning style may be considered as more suitable for particular professions or occupations and that in such circumstances assessments that advantage certain learners over others may be used to ‘weed out’ unsuitable candidates, this is not the case in the context of this research study. Activist learners currently being assessed on the academic modules of the BTEC (NC) in aerospace engineering are almost certainly disadvantaged by the existing system and this affects the validity of the assessment scheme. To help reduce this problem in the short term, I would suggest that a move away from formal examinations and the inclusion of more written and laboratory assignments would be a desirable step forward. There is evidence to suggest that if we remove the time constraints, then learners become more adaptable and more able to tackle problems that incorporate a wider range of knowledge types. This unfortunately, contradicts the current BTEC/EDEXCEL (2000) proposals that are designed to satisfy the criteria for inclusion in the National Qualifications Framework (NQF). These proposals include a move back to summative external examinations for a number of core units, while others will be assessed through portfolio assessment based upon a set of evidence requirements. The evidence from this report suggests that a move back to external examinations will further disadvantage certain groups of learners leading to a significant reduction in validity across the assessment scheme.

Chapter 8: The Validity and Relevance of this Research Study.

In this closing section, it remains for me to subject this research study to an element of self-evaluation in terms of its own validity and its relevance to a wider audience. To achieve this aim I shall use the criteria suggested by the authors of the E835 Open University study guide (1996) who state that all claims and conclusions contained within a research study should be assessed for validity in terms of their plausibility and their credibility. In terms of the latter, if my claims and conclusions are to be accepted as credible, then the reader must be confident that they are worthy of belief. I have drawn two conclusions from this study both of which I feel are supported by strong evidence, and both of which have been researched using tried and tested techniques. Both conclusions are based upon documentary analysis and both have been subjected to respondent validation by many of the lecturers who use the assessment instruments. The evidence seems clear and consistent, and on this basis I would argue that they are indeed credible and worthy of belief. In terms of plausibility, I feel that my conclusions are wholly reasonable. Lecturers who have been involved with the BTEC (NC) academic modules at RAF Cosford for many years have verified my findings and agree that my depiction of the nature of assessment is an accurate one and my concerns regarding validity are based on sound reasoning.

My evidential claims are likely to be subjected to more rigorous scrutiny. Not only will readers consider whether they are plausible and credible, they will also wish to consider whether I have been 'objective', or as Phillips (1989) puts it, whether this study carries the "stamp of approval" (1989 Page 71). Certainly, my evidential claims are credible. Few people would argue with the fact that we are all different when it comes to individual learning styles. What this study aimed to do was to provide evidence for this belief and to investigate the impact of these differences during assessment. If we are to generalise the findings, we must remember that this study was only concerned with the academic modules that make up the BTEC (NC), and that the trade related or practical modules may yield contradictory results. Nonetheless, my hypothesis was that certain types of learner might be disadvantaged during assessment as a result of their individual learning style and that this has implications for the reliability and validity of an assessment scheme. Based on the evidence of this enquiry there is strong evidence to suggest that there is at least a case for more extensive

research. Activists within my sample have achieved worse results than other types of learner and though there are other factors to consider (see page 174 of this report), it seems apparent that the individual learning style of these students is at least partly to blame for this scenario. I also tried to establish links between learning styles, assessment and the different types of knowledge being tested. Evidence from this area of research seems to suggest that conceptual and procedural knowledge at level 'b' is less reactive than level 'a' knowledge types, consequently, the individual learning style of the student appears to have less impact where level 'b' knowledge is under assessment. Again, this suggestion seems credible and plausible, though, this area of research needs extending to include an element of 'item analysis' if the claim is to be substantiated.

On the issue of objectivity, Phillips (1989) writes about:

“inquiries that are prized because of the great care and responsiveness to criticism with which they have been carried out”

(1989 Page 71)

I feel that if my investigation is to be judged on these criteria, then I have at least succeeded in achieving a passable level of objective legitimacy if for no other reasons than honesty and assiduousness. Nevertheless, I feel that Eisner (1992) probably offers the most realistic assessment of objectivity as applied to case study research. Quoting Toulmin (1982), he suggests that:

“belief, supported by good reasons, is a reasonable and realistic aim for inquiry”

(1992 Page 55)

My belief is that the evidence provided by this research is strong and convincing. As Eisner states:

“What we believe, in the end, is what we ourselves create”

(1992 Page 55)

What I have created is a case for further research into the impact of individual learning styles during summative assessment. If the evidence is to be believed, then Phillips' 'stamp of approval' may be confidently applied to this work.

Finally, if this study is to be classified as valid, it must have relevance, hence, it is important for me to identify who I consider to be the audience for this research. I would suggest that in general terms I may categorise the audience into two distinct groups. Firstly, there are the policy makers within the RAF course design teams who determine many aspects of the overriding assessment scheme and use the results to make important decisions relating to RAF personnel. Also in this category are the lecturers within the RAF and the MOD, BTEC/EDEXCEL policymakers and verifiers and the wider audience within further education who have similar assessment schemes within their own institutions. In the second group, I would suggest that this is a study that will be of interest and relevance to other educational researchers, particularly those working for the QCA and related bodies such as cdell, who were commissioned to carry out research into 'fair assessment'. The study of individual learning styles is a fairly recent phenomenon and thus far has been mainly used in industry and commerce as a tool for producing more effective managers. During the last five years the identification and effects of individual learning styles have slowly become more prominent in educational research though as yet, this area of educational psychology remains underdeveloped. Hopefully, this study will add to existing knowledge in this field both in terms of the methodology developed to identify individual learning styles and the possible impact of each individual style during assessment. If, as I have suggested, it can be demonstrated that certain learners are disadvantaged due to their individual learning style, and that certain knowledge types are more reactive than others, this may ultimately lead to a radical re-think in the way we assess students.

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Literature Review

Appendices

- A) Skill area aims, performance criteria and range statement. (Applying numeracy).
- B) Kolb's Learning Styles Inventory. (9 Item Test).
- C) Honey & Mumfords LSQ.
- D) Honey & Mumford's LSQ score sheet.
- E) Honey & Mumford's LSQ profile.

Section B

Applying Numeracy

Skill Area Aims

This skill area enables learners to:

- a. utilise and apply a range of numerical skills and techniques
- b. develop through application an understanding and appreciation of the role of numerical skills and techniques

Outcome 15

Apply numerical skills and techniques

Performance Criteria

- a. Use and application of numerical techniques identified.
- b. Appropriate techniques selected and applied.
- c. Numerical information correctly interpreted.
- d. Valid conclusions drawn.

Range Statement

Skills And Techniques

- use of calculators
- interpretation and recording of data
- calculating
- estimating/approximating

Situation

- individual
- group

LEARNING STYLE INVENTORY

Instructions

There are nine sets of four words listed below. Rank-order the words in each set by assigning a 4 to the word that best characterizes your learning style, a 3 to the word that next best characterizes your learning style, a 2 to the next most characteristic word, and a 1 to the word that is least characteristic of you as a learner.

You may find it hard to choose the words that best characterize your learning style. Nevertheless, keep in mind that there are no right or wrong answers -all the choices are equally acceptable. The aim of the inventory is to describe how you learn, not to evaluate your learning ability.

Be sure to assign a different rank number to each of the four words in each set; do not make ties.

1. discriminating	tentative	involved	practical
2. receptive	relevant	analytical	impartial
3. feeling	watching	thinking	doing
4. accepting	risk-taker	evaluative	aware
5. intuitive	productive	logical	questioning
6. abstract	observing	concrete	active
7. present-orientated	reflecting	future-orientated	pragmatic
8. experience	observation	conceptualization	experimentation
9. intense	reserved	rational	responsible

The four columns of words above correspond to the four learning style scales: CE, RO, AC, and AE. To compute your scale scores, write your rank numbers in the boxes below only for the designated items. For example, in the third column (AC), you would fill in the rank numbers you have assigned to items 2, 3, 4, 5, 8 and 9. Compute your scale scores by adding the rank numbers for each set of boxes.

234578

CE = _____

234578

RO = _____

234578

AC = _____

234578

AE = _____

To compute the two combination scores, subtract CE from AC and subtract RO from AE. Preserve negative signs if they appear.

AC – CE: - =

AE – RO: - =

LEARNING STYLES QUESTIONNAIRE

revised 1986

This questionnaire is designed to find out your preferred learning style(s). Over the years you have probably developed some learning 'habits' that help you benefit more from some experiences than from others. Since you are probably unaware of this, this questionnaire will help you pinpoint your learning preferences so that you are in a better position to select learning experiences that suit your style.

There is no time limit to this questionnaire. It will probably take you 10 – 15 minutes. The accuracy of the results depends on how honest you can be. There are no right or wrong answers. If you agree more than you disagree with a statement put a tick by it (✓). If you disagree more than you agree put a cross by it (×). Be sure to mark each item with either a tick or cross.

- ☐ 1. I have strong beliefs about what is right and wrong, good or bad.
- ☐ 2. I often act without considering the possible consequences.
- ☐ 3. I tend to solve problems using a step by step approach.
- ☐ 4. I believe that formal procedures and policies restrict people.
- ☐ 5. I have a reputation for saying what I think. Simply and directly.
- ☐ 6. I often find that actions based on feelings are as sound as those based on careful thought and analysis.
- ☐ 7. I like the sort of work where I have time for thorough preparation and implementation.
- ☐ 8. I regularly question people about their basic assumptions.
- ☐ 9. What matters most is whether something works in practice.
- ☐ 10. I actively seek out new experiences.
- ☐ 11. When I hear about a new idea or approach I immediately start working out how to apply it in practice.
- ☐ 12. I am keen on self discipline such as watching my diet, taking regular exercise, sticking to a fixed routine etc.
- ☐ 13. I take pride in doing a thorough job.
- ☐ 14. I get on best with logical, analytical people and less well with spontaneous, 'irrational' people.
- ☐ 15. I take care over the interpretation of data available to me and avoid jumping to conclusions.
- ☐ 16. I like to reach a decision carefully after weighing up many alternatives.
- ☐ 17. I'm attracted more to novel, unusual ideas than to practical ones.
- ☐ 18. I don't like disorganised things and prefer to fit things into a coherent pattern.

- ☐ 19. I accept and stick to laid down procedures and policies so long as I regard them as an efficient way of getting the job done.
- ☐ 20. I like to relate my actions to a general principle.
- ☐ 21. In discussions I like to get straight to the point.
- ☐ 22. I tend to have distant, rather formal relationships with people at work.
- ☐ 23. I thrive on the challenge of tackling something new or different.
- ☐ 24. I enjoy fun-loving, spontaneous people.
- ☐ 25. I pay meticulous attention to detail before coming to a decision.
- ☐ 26. I find it difficult to produce ideas on impulse.
- ☐ 27. I believe in coming to the point immediately.
- ☐ 28. I am careful not to jump to conclusions too quickly.
- ☐ 29. I prefer to have as many sources of information as possible – the more data to think over the better.
- ☐ 30. Flippant people who don't take things seriously enough usually irritate me.
- ☐ 31. I listen to other peoples points of view before putting my own forward.
- ☐ 32. I tend to be open about how I'm feeling.
- ☐ 33. In discussions I enjoy watching the manoeuvrings of the other participants.
- ☐ 34. I prefer to respond to events on a spontaneous, flexible basis rather than plan things out in advance.
- ☐ 35. I tend to be attracted to techniques such as network analysis, flow charts, branching programmes, contingency planning etc.
- ☐ 36. It worries me if I have to rush out a piece of work to meet a tight deadline.
- ☐ 37. I tend to judge peoples ideas on their practical merits.
- ☐ 38. Quiet, thoughtful people tend to make me feel uneasy.
- ☐ 39. I often get irritated by people who want to rush things.
- ☐ 40. It is more important to enjoy the present moment than to think about the past or future.
- ☐ 41. I think that decisions based on a thorough analysis of all the information are sounder than those based on intuition.
- ☐ 42. I tend to be a perfectionist.
- ☐ 43. In discussions I usually produce lots of spontaneous ideas.
- ☐ 44. In meetings I put forward practical, realistic ideas.
- ☐ 45. More often than not, rules are there to be broken.
- ☐ 46. I prefer to stand back from a situation and consider all the perspectives.

- ☐ 47. I can often see inconsistencies and weaknesses in other people's arguments.
- ☐ 48. On balance I talk more than I listen.
- ☐ 49. I can often see better, more practical ways to get things done.
- ☐ 50. I think written reports should be short and to the point.
- ☐ 51. I believe that rational, logical thinking should win the day.
- ☐ 52. I tend to discuss specific things with people rather than engaging in social discussion.
- ☐ 53. I like people who approach things realistically rather than theoretically.
- ☐ 54. In discussions I get impatient with irrelevancies and digressions.
- ☐ 55. If I have a report to write I tend to produce lots of drafts before settling on the final version.
- ☐ 56. I am keen to try things out to see if they work in practice.
- ☐ 57. I am keen to reach answers via a logical approach.
- ☐ 58. I enjoy being the one that talks a lot.
- ☐ 59. In discussions I often find that I am the realist, keeping people to the point and avoiding wild speculations.
- ☐ 60. I like to ponder many alternatives before making up my mind.
- ☐ 61. In discussions with people I often find I am the most dispassionate and objective.
- ☐ 62. In discussions I'm more likely to adopt a 'low profile' than to take the lead and do most of the talking.
- ☐ 63. I like to be able to relate current actions to a longer term bigger picture.
- ☐ 64. When things go wrong I am happy to shrug it off and 'put it down to experience'.
- ☐ 65. I tend to reject wild, spontaneous ideas as being impractical.
- ☐ 66. Its best to think carefully before taking action.
- ☐ 67. On balance I do the listening rather than the talking.
- ☐ 68. I tend to be tough on people who find it difficult to adopt a logical approach.
- ☐ 69. Most times I believe the end justifies the means.
- ☐ 70. I don't mind hurting peoples feelings as long as the job gets done.
- ☐ 71. I find the formality of having specific objectives and plans stifling.
- ☐ 72. I'm usually one of the people who puts life into a party.
- ☐ 73. I do whatever is expedient to get the job done.
- ☐ 74. I quickly get bored with methodical, detailed work.

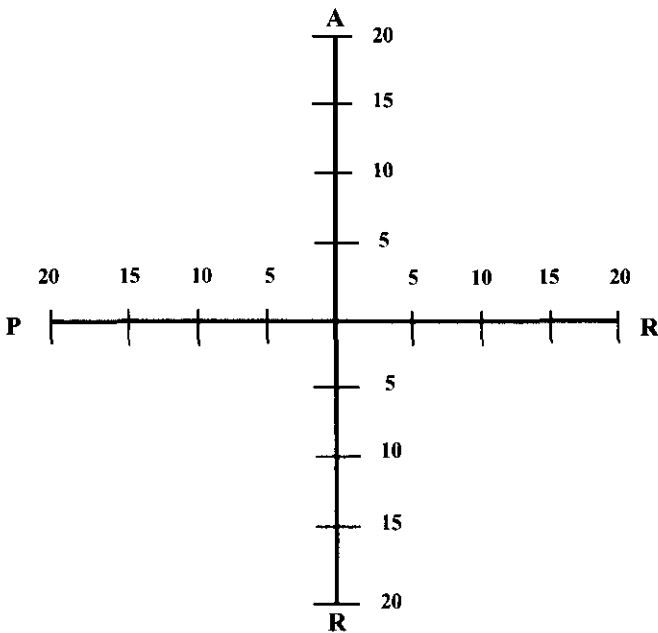
- ☐ 75. I am keen on exploring the basic assumptions, principles and theories underpinning things and events.
- ☐ 76. I'm always interested to find out what people think.
- ☐ 77. I like meetings to be run on methodical lines, sticking to laid down agenda, etc.
- ☐ 78. I steer clear of subjective or ambiguous topics.
- ☐ 79. I enjoy the drama and excitement of a crisis situation.
- ☐ 80. People often find me insensitive to their feelings.

LEARNING STYLES QUESTIONNAIRE - SCORING

You score one point for each item that you ticked on the LSQ. There are no points for items that you crossed. Simply indicate on the lists below which items were ticked.

2	7	1	5
4	13	3	9
6	15	8	11
10	16	12	19
17	25	14	21
23	28	18	27
24	29	20	35
32	31	22	37
34	33	26	44
38	36	30	49
40	39	42	50
43	41	47	53
45	46	51	54
48	52	57	56
58	55	61	59
64	60	63	65
71	62	68	69
72	66	75	70
74	67	77	73
79	76	78	80
<hr/>			
<hr/>			
Activist	Reflector	Theorist	Pragmatist

Plot the scores on the arms of the cross below and apply the appropriate norms from section one (pages 3 – 10) in the booklet “Using Your Learning Styles”.



L.S.Q. Profile Based on General Norms for 1302 People.

Activist	Reflector	Theorist	Pragmatist	
20	20	20	20	Very Strong Preference
19		19	19	
18		18	18	
17	19	17	17	
16		16	16	
15		15	15	
14		14	14	
13	18	13	13	Strong Preference.
12	17	12	12	
11	16	11	11	
10	15	10	10	Moderate Preference.
9	14	9	9	
8	13	8	8	
7	12	7	7	
6	11	6	6	Low Preference.
5	10	5	5	
4	9	4	4	
3	8	3	3	Very Low Preference.
2	7	2	2	
1	6	1	1	
0	5	0	0	
	4			
	3			
	2			
	1			
	0			

Honey.P. & Mumford.A. 1986 page 75

Methodology

Appendices

- F) Blank Content Validity Nomograph.
- G) Blank 'Weightings' Nomograph..
- H) Documentary Assignment Analysis (Sheet 1).
- I) Documentary Assignment Analysis (Sheet 2).
- J) Documentary Assignment Analysis (Sheet 3).
- K) Observation Schedule.
- L) Knowledge Evaluation Criteria.
- M) Knowledge Evaluation Sheet 1.
- N) Knowledge Evaluation Sheet 2.

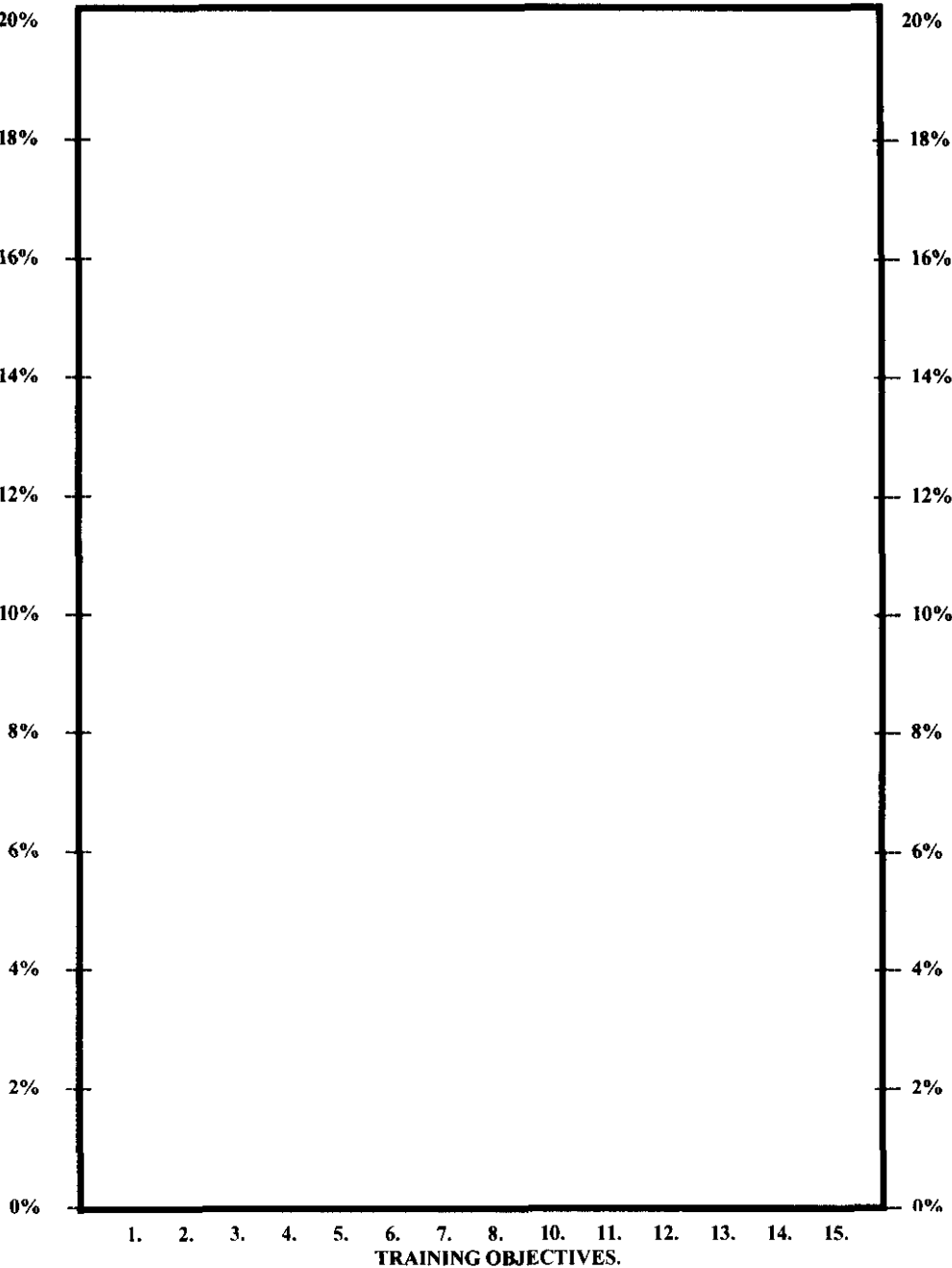
CONTENT VALIDITY – (Assessment Question/Training Objective).

	ASSESSMENT INSTRUMENT: _____	
QU.14.		T.O. 1.1.
QU.13.		T.O. 1.2
QU.12.		T.O. 1.3.
QU.11.		T.O. 1.4.
QU.10.		T.O. 1.5.
QU.9.		T.O. 1.6.
QU.8.		T.O. 1.7.
QU.7.		T.O. 1.8.
QU.6.		T.O. 1.10.
QU.5.		T.O. 1.11.
QU.4.		T.O. 1.12.
QU.3.		T.O. 1.13.
QU.2.		T.O. 1.14.
QU.1.		T.O. 1.15.

Key to Training Objectives: T.O. 1.1. – Electronic Aids. T.O. 1.2 – Decimals, Percentages, Indices & Logarithms. T.O. 1.3 - Tables & Charts. T.O. 1.4 – Numbering & Measuring Systems.	 T.O. 1.5. – Formulae & Substitution. T.O. 1.6. – Areas, Perimeters & Mass. T.O. 1.7. – Surface Area & Volume. T.O. 1.8. – Graphs & Linear Laws. T.O. 1.10. – Linear, Quadratic & Simultaneous Eqn's.	 T.O. 1.11. – Calculus T.O. 1.12. – Trigonometry. T.O. 1.13. – Vectors. T.O. 1.14. – Complex Numbers. T.O. 1.15. – Statistics.
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CONTENT VALIDITY – (Assessment Weighting/Syllabus Weighting).

ASSESSMENT
INSTRUMENT: _____



Key to Training Objectives: T.O. 1.1. – Electronic Aids. T.O. 1.2 – Decimals, Percentages, Indices & Logarithms. T.O. 1.3 - Tables & Charts. T.O. 1.4 – Numbering & Measuring Systems.	T.O. 1.5. – Formulae & Substitution. T.O. 1.6. – Areas, Perimeters & Mass. T.O. 1.7. – Surface Area & Volume. T.O. 1.8. – Graphs & Linear Laws. T.O. 1.10. – Linear, Quadratic & Simultaneous Eqn's.	T.O. 1.11. – Calculus T.O. 1.12. – Trigonometry. T.O. 1.13. – Vectors. T.O. 1.14. – Complex Numbers. T.O. 1.15. – Statistics.
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DOCUMENTARY ASSIGNMENT ANALYSIS

Module No. & Title:

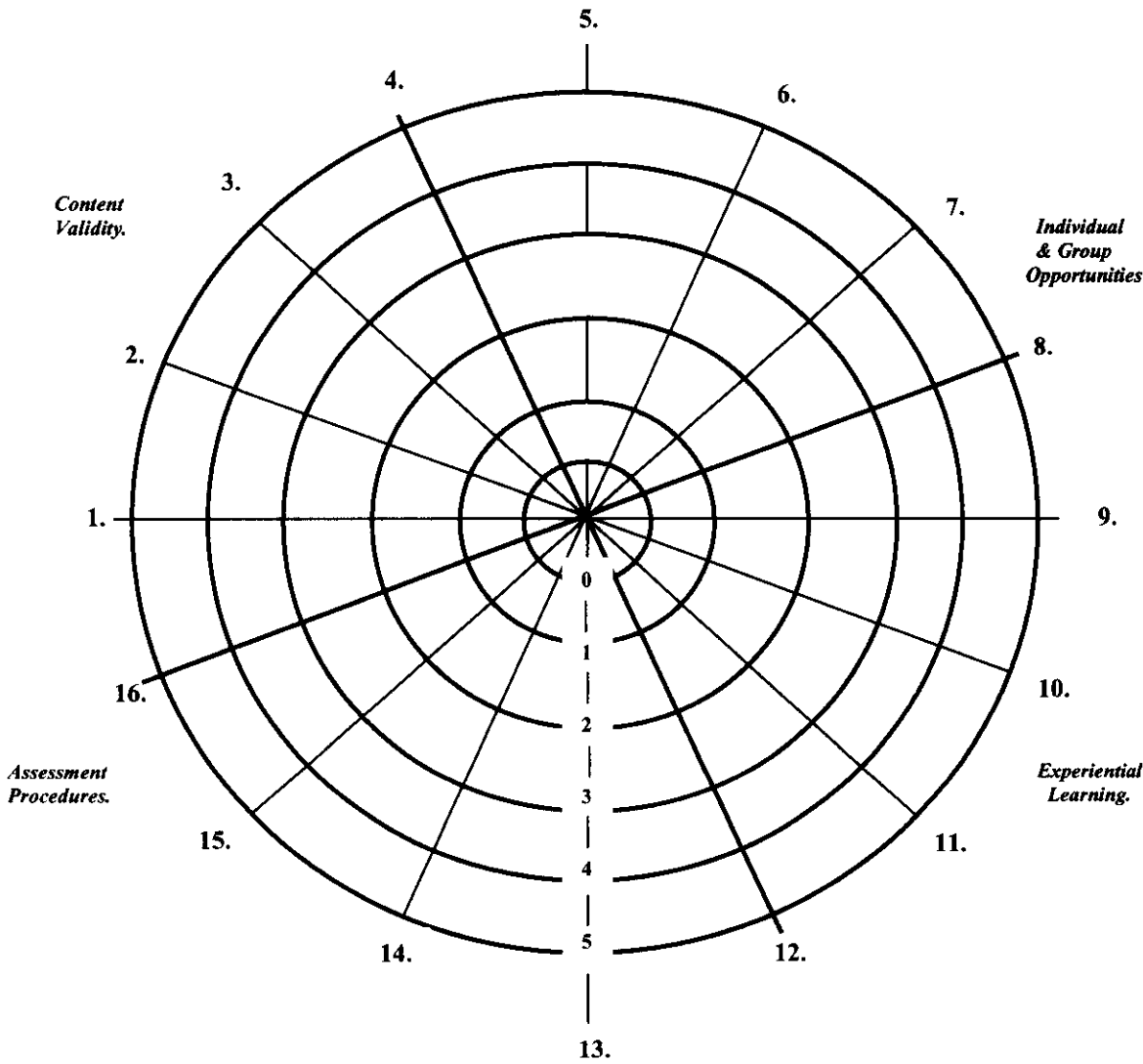
Assignment No. & Title:

Assignment Characteristics.	<div>Positive ←————→ Negative</div>					
	5	4	3	2	1	0
1. Is the assignment realistic?						
2. Does it test relevant outcomes?						
3. Is the degree of difficulty correct?						
4. Does it reflect the TO's and EO's in the IS?						
5. Are there opportunities for individual planning?						
6. Are there opportunities for group planning?						
7. Are there opportunities for individual tasks?						
8. Are there opportunities for group tasks?						
9. Does it provide opportunities for conceptualisation?						
10. Does it provide opportunities to plan an activity?						
11. Does it provide opportunities for experimentation?						
12. Does it provide opportunities for reflection?						
13. Is there an assessment scheme?						
14. Is the assessment criteria made clear?						
15. Is there grading criteria?						
16. Are there opportunities to assess common skills?						

ASSIGNMENT STATISTICS ANALYSIS.

Module No. & Title:

Assignment No. & Title:

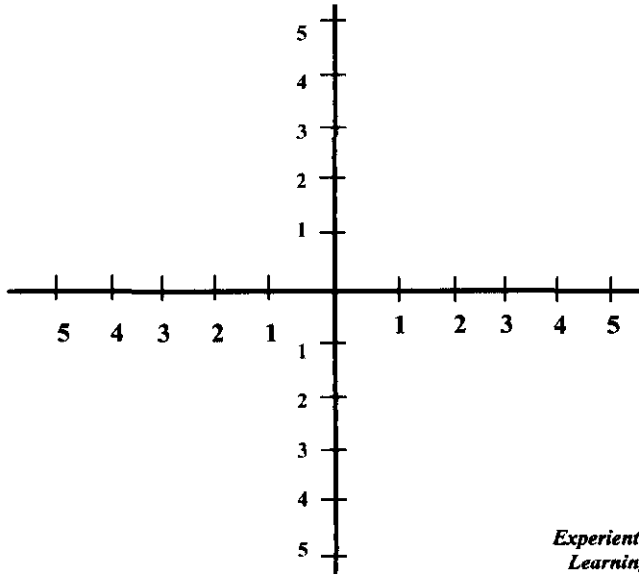
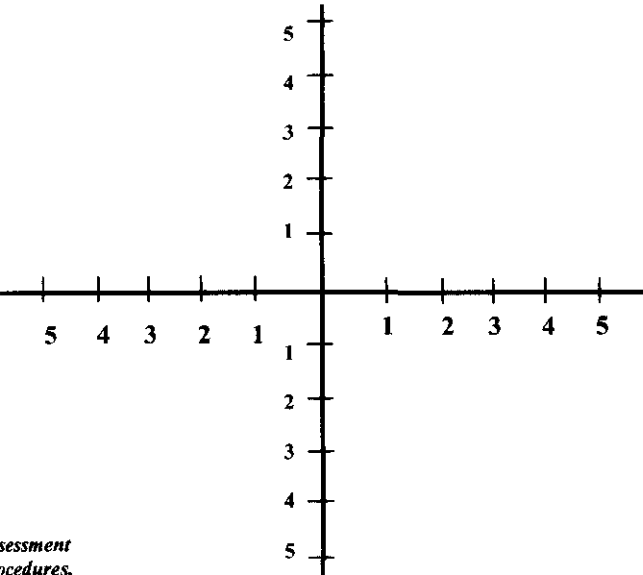
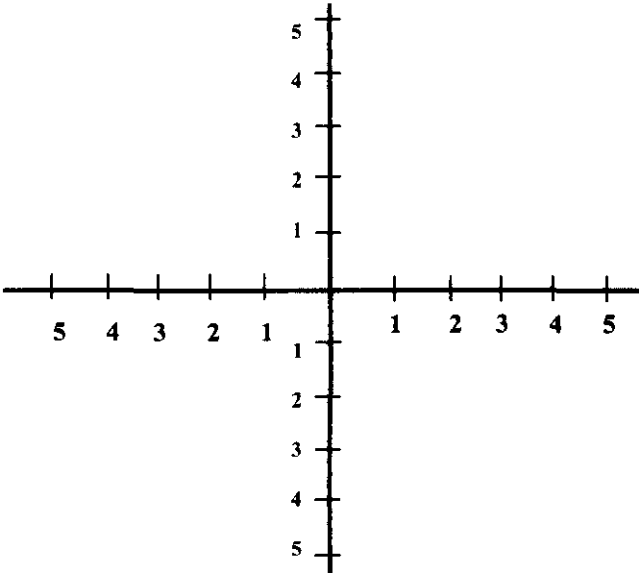
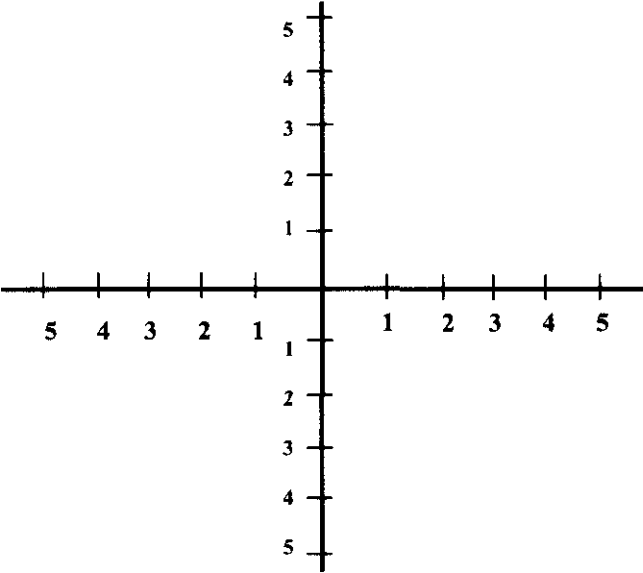


Appendix I-1

ASSIGNMENT STATISTICS ANALYSIS.

Content Validity.

*Individual &
Group
Opportunities.*



*Assessment
Procedures.*

*Experienced
Learning.*

OBSERVATION SCHEDULE.

BTEC MODULE:

LESSON TITLE:	T.O.
----------------------	-------------

DATE:	LESSON CONTENT – E.O.’s
--------------	--------------------------------

How was the Task Presented?

What Opportunities for Practice were Provided for the Students?
--

How was Mastery Assessed?

Teaching Strategy Comments (Continue overleaf if necessary):

Criteria for Knowledge Evaluation.

The following criteria will be used to identify the four different knowledge types that form the basis of this study. The criteria used is that identified by Hiebert (1986):

CONCEPTUAL KNOWLEDGE LEVEL ‘a’:

Conceptual knowledge at level ‘a’ involves relationships between pieces of information but it is ‘context specific’. From an assessment point of view, this type of knowledge would require the learner to ‘network’ between different knowledge banks in order to solve context specific problems. The level of abstractness involved should be equal to, or less than, that at which the information in the problem is represented. An example of this type of knowledge may be inherent in a simple mathematical calculation. Consider the following example:

$$7 + (8 \div 2) \times 6 - 3 =$$

On the face of it this problem may appear procedural. If we look more closely, however, to solve it we must also link context specific concepts. Firstly we must understand the concepts of addition, subtraction, multiplication and division, and secondly, we must understand the concept of arithmetic order. To obtain the correct answer, we must link each of those context specific concepts and this would represent level ‘a’ conceptual knowledge. (The answer of course is 28)!

CONCEPTUAL KNOWLEDGE LEVEL ‘b’:

Conceptual knowledge at level ‘b’ involves relationships at a higher more abstract level than the pieces of information they connect. We may call this the reflective level as relationships are less tied to specific contexts. Consider the following example:

$$a + (b \div c) \times b - a =$$

To solve this problem the learner would have to reflect upon the concepts used above and apply them in a different context. This would involve making a link between the two problems, which are similar, and working out that the same concepts could be applied in each case. This would involve conceptual knowledge at level ‘b’. (The answer in this case is $\frac{b^2}{c}$).

PROCEDURAL KNOWLEDGE LEVEL ‘a’:

Procedural knowledge at level ‘a’ involves executing procedures that are of a symbolic nature. A large percentage of elementary mathematics involves procedures of this type where the task requires the learner to transform the symbolic expression from the given form to answer form by executing a sequence of symbol manipulation rules. Consider the example below:

$$5 + \sqrt{16} - 3 =$$

As we have seen this problem involves some level ‘a’ conceptual knowledge, however, it also involves level ‘a’ procedures. To obtain an answer we must be able to execute a sequence of symbol manipulation. Problems such as this have been labelled ‘visually-moderated sequences, as they involve procedures whose input and output are visual symbol patterns. (The answer here is 6).

PROCEDURAL KNOWLEDGE LEVEL ‘b’:

Procedural knowledge at level ‘b’ involves a problem solving strategy or action that operates on concrete objects, visual diagrams, mental images or other objects that are not standard symbols. In other words, procedural knowledge at this level is non-symbolic. Consider the following example:

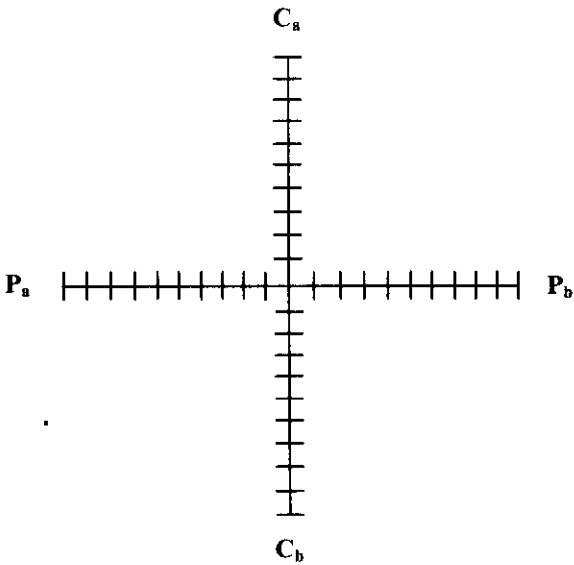
Using a ruler, compass and pencil, construct a parallelogram.

To carry out this task the learner must adopt a problem solving strategy that will also involve some conceptual knowledge. The task is non-symbolic and may involve sub-procedures. For example, to draw one line parallel to another using the equipment listed the learner must draw one line, place the compass point on it and draw an arc at a set distance from it, move along the line and draw a second arc at the same distance from it and then use the ruler and pencil to draw a tangent across the two arcs. Each of these operations is a sub-procedure, and the task described involves level ‘b’ procedural knowledge.

Knowledge Evaluation Sheet.

ASSESSMENT PAPER N°:

Qu.N°.	C L _a	C L _b	P L _a	P L _b	Comments
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
Totals:					

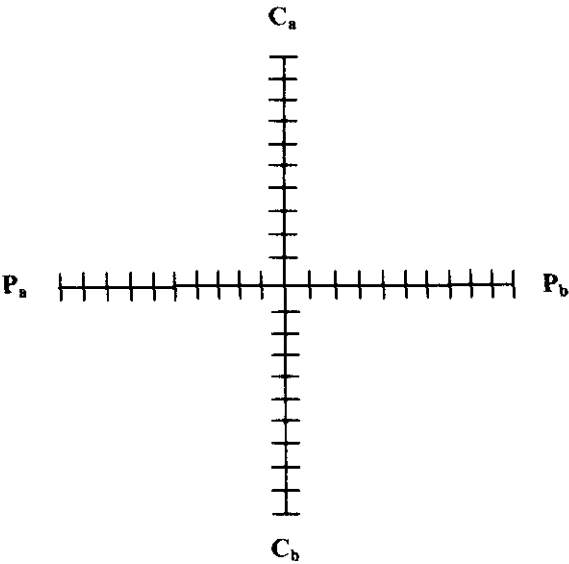


Overall Comments:

Knowledge Evaluation Sheet.

OVERALL SUMMARY:

Paper	C L _a	C L _b	P L _a	P L _b	Comments.
AB100					
AB102					
AB598					
AB602					
AB604					
Totals:					



Overall Comments:

Findings

Appendices

- O) Table of Documentary Evidence.
- P) Common Skill Range Statements & Performance Indicators.
- Q) Cert.4.
- R) Materials Science Assessment Strategy.
- S) Electrical Principles Assessment Strategy.
- T) Electrical AC Revision Paper – Nomograph.
- U) Engineering Science Circular Motion Post Test – Nomograph.
- V) Mathematics mid-phase Consolidation Paper – Nomograph.
- W) Mathematics end-phase Consolidation Paper – Nomograph.
- X) Materials Science Examination – Nomograph.
- Y) Activist Table of Results – Levels 1 – 3.
- Z) Reflector Table of Results – Levels 1 – 3.
- AA) Theorist Table of Results – Levels 1 – 3.
- BB) Pragmatist Table of Results – Levels 1 – 3.
- CC) Table of Results for ‘Hub’ Learners.

TABLE OF DOCUMENTARY EVIDENCE.

MATHEMATICS	MATERIALS SCIENCE	ENGINEERING SCIENCE	ELECTRICAL PRINCIPLES
1. Diagnostic Test.	1. Structure of Matter Training Notes.	1. Fluids-Flow Measurement Trg.Notes. (Progress Questions Inherent).	1. Introduction to Electricity Trg.Notes. (Including consolidation questions & Post tests).
2. Pre-Technician Test.	2. Structure of Matter Consolidation Questions.	2. Motion in a Circle Trg.Notes.(Post Tests Included).	2. Basic Principles of AC Trg Notes. (Including consolidation questions & Post tests).
3. Maths mid-phase Consolidation Paper.	3. Materials and Forces Training Notes.	3. Machines – Revision Paper.	3. DC Revision Papers.
4. Maths end-phase Consolidation Paper.	4. Materials and Forces Consolidation Questions.	4. Friction – Revision Paper.	4. AC Revision Papers.
5. Maths mid-phase Revision Paper.	5. Materials Science Assignment.	5. Engineering Science Assignments: i) Machines. ii) Turning Moments.	5. Basic Electricity Exam (1).
6. Maths end-phase Revision Paper.	6. Materials Science Revision Papers.	6. Engineering Science mid-phase Exam.	6. Basic Electricity Exam (2).
7. Maths mid-phase exam.	7. Materials Science Exams.	7. Engineering Science end-phase exam.	
8. Maths end-phase exam.			
9. Transposition Work Sheet.			
10. Blank RAF cert.4.			

COMMON SKILLS LOG BOOK - BTEC COMMON SKILLS CRITERIA.

Managing Tasks and Solving Problems.

Skill Area Aims

This skill area enables learners to:

- a gather and use information from a variety of sources in completing relevant tasks.
- b carry out a variety of tasks in an organised way to complete tasks more efficiently and effectively by planning action.
- c utilise a range of techniques to solve given problems effectively, determining the appropriate timescales.

Outcome 12 *Use information sources*

Performance Criteria:

- a Scope and nature of tasks defined from a received brief.
- b Nature of required information identified.
- c Information located and collected, through appropriate data collection techniques.
- d Relevant materials collected and collated into usable format.

Range Statement:

Tasks

- Defined by others
- Self defined

Sources of Information

- Experts
- Manuals/textbooks
- Surveys/tables/data-bases

Techniques

- Interviewing/questioning
- Indices
- Library/computerised searches

COMMON SKILLS GENERAL GUIDELINE 80-037-2 ISSUE 1 MAY 1992

Com0003

Restricted staff (When completed)

CERT 4 OCCURRENCE REPORT No:.....

(To be completed by parent admin area)

Adverse _____ Laudatory _____ Other _____

Number: _____ Rank: _____ Name: _____ Initials: _____			
Course No: _____ Trg Flt: _____ Occurrence Date: _____			
Reason for report: _____			
Exam code & Title: _____ Type: Major Progress Other			
EXAMINATION PERFORMANCE		Original mark: _____ % Re-sit mark: _____ % Class average: _____ %	
INSTRUCTORS COMMENTS		Interviewed	Y/N Date: _____
Rank: _____ Name: _____ Signature: _____ Date: _____			
Trg SUPERVISOR COMMENTS/RECOMMENDATIONS: Interviewed Y/N Date: _____			
Rank: _____ Name: _____ Signature: _____ Date: _____			
OC Trg Flt's COMMENTS/RECOMMENDATIONS: Interviewed Y/N Date: _____			
Rank: _____ Name: _____ Signature: _____ Date: _____			
* Any recommendations are subject to ratification by the parenting squadron*			

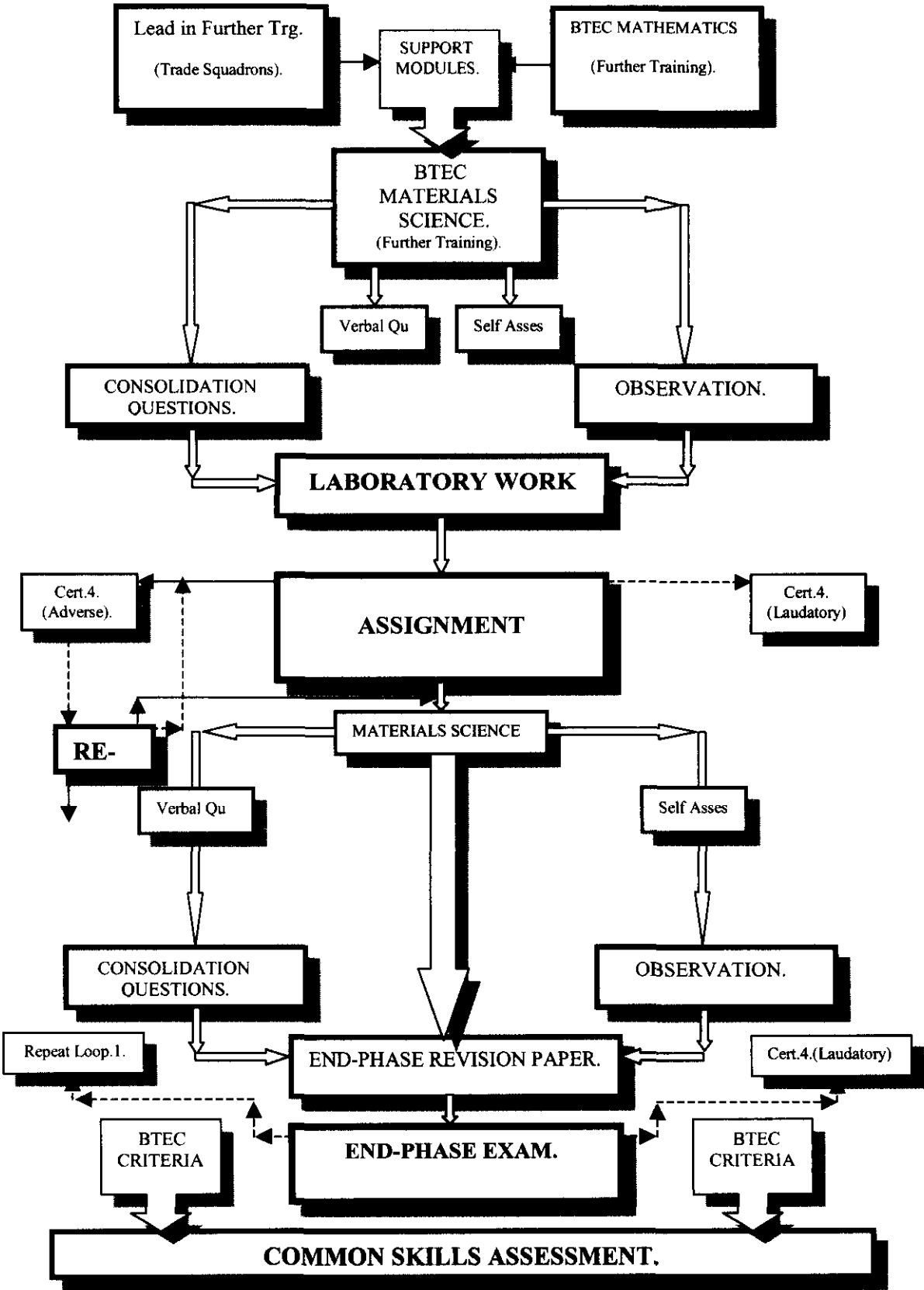
DATE RECEIVED FROM EXTERNAL Trg AREA: _____

PARENT Sqd Trg SUPERVISOR'S COMMENTS: Interviewed				Y/N	Date: _____
Rank: _____ Name: _____ Signature: _____ Date: _____					
STUDENT ADMIN Flt Cdr's COMMENTS:				Interviewed	Y/N Date: _____
Rank: _____ Name: _____ Signature: _____ Date: _____					
STUDENT Trg OFFICER'S COMMENTS/RECOMMENDATIONS: Interviewed				Y/N	Date: _____
Rank: _____ Name: _____ Signature: _____ Date: _____					
STUDENT Sqd Cdr's DECISION:				Interviewed	Y/N Date: _____
Rank: _____ Name: _____ Signature: _____ Date: _____					

ACTION	For filing only	
	Sqd review board required	
	Wino review board required	

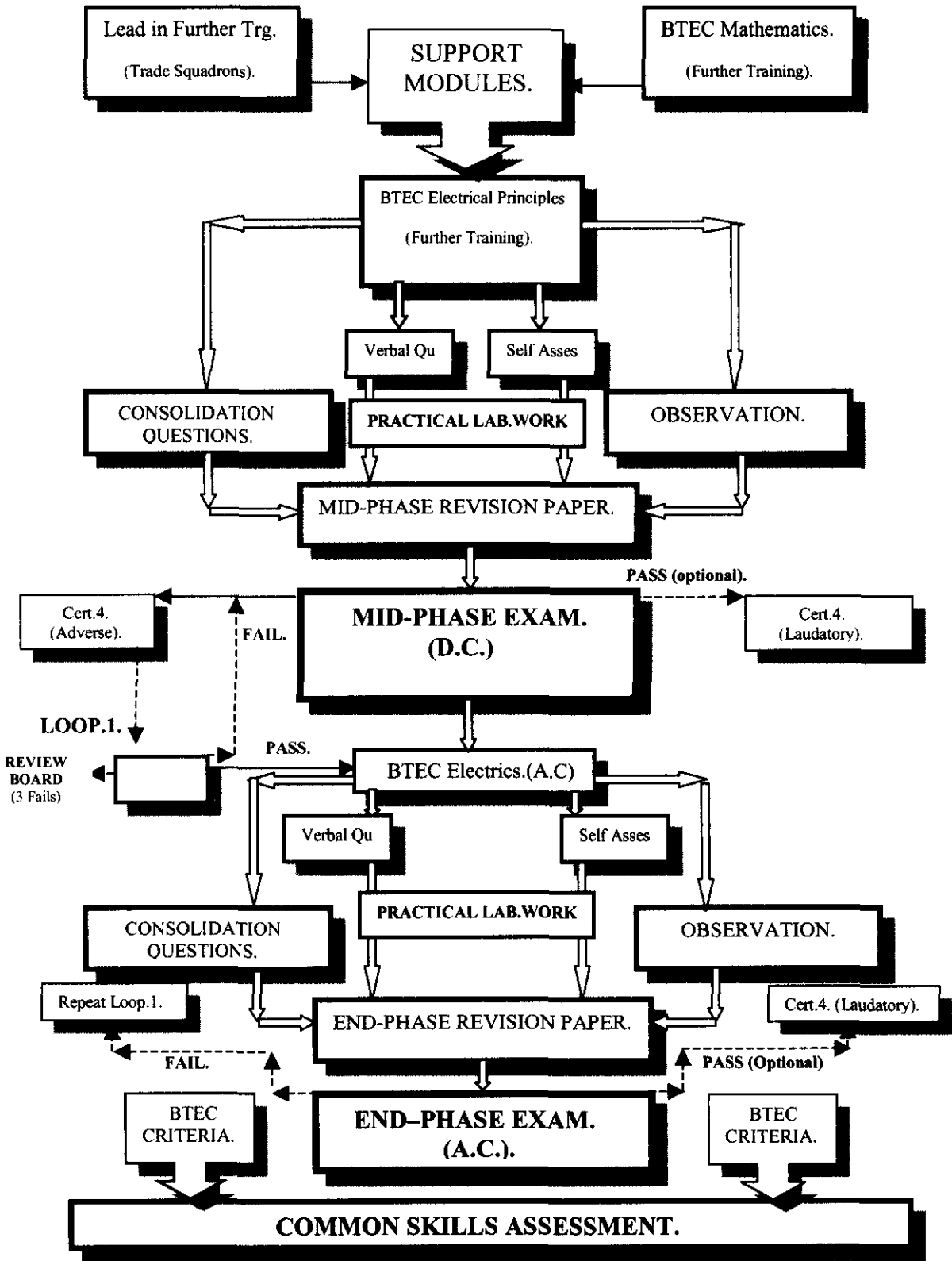
Decision actioned by: Name: _____ Signature: _____ Date: _____
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BTEC MATERIALS SCIENCE ASSESSMENT STRATEGY

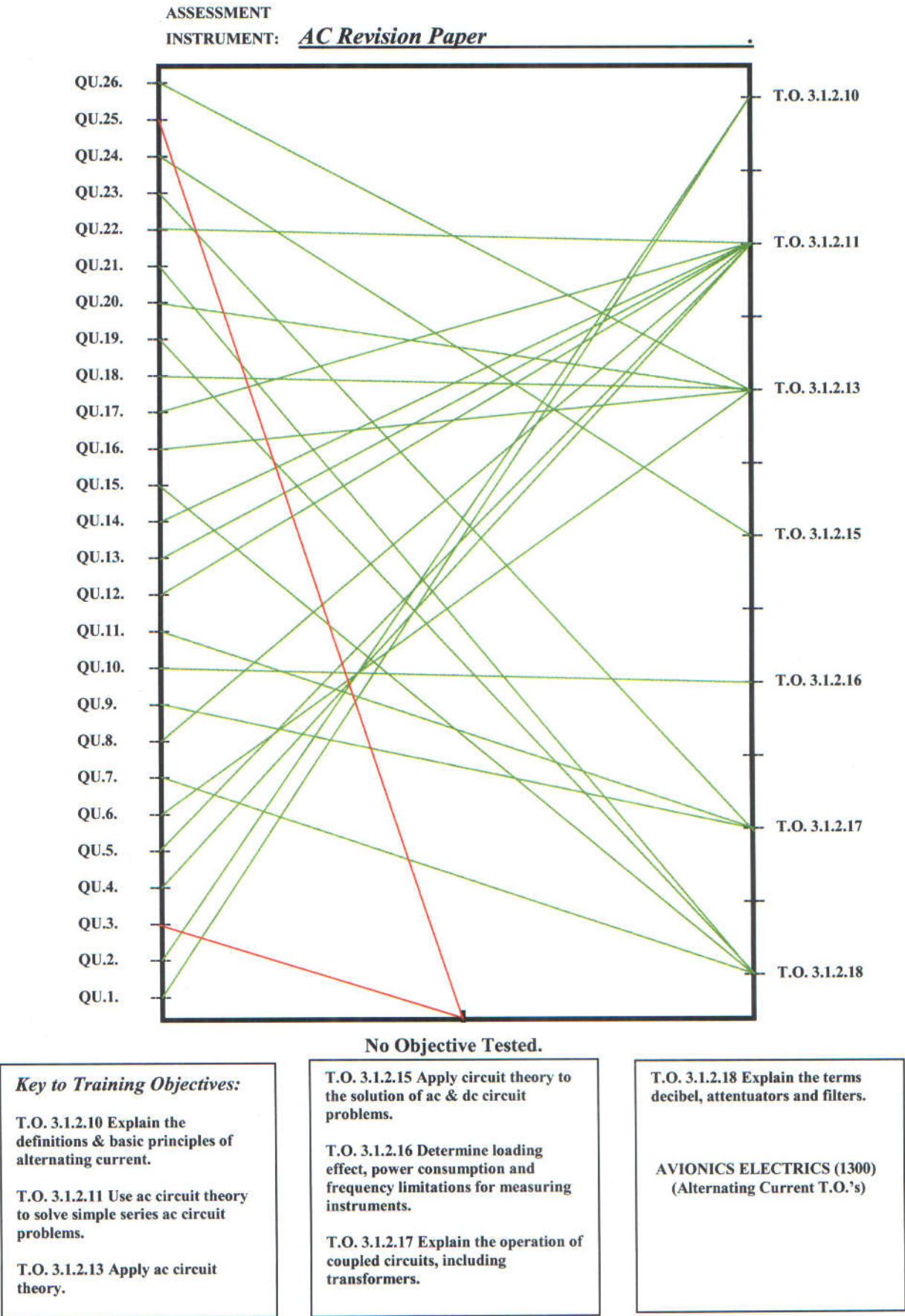


Appendix R-1

BTEC ELECTRICAL PRINCIPLES ASSESSMENT STRATEGY.

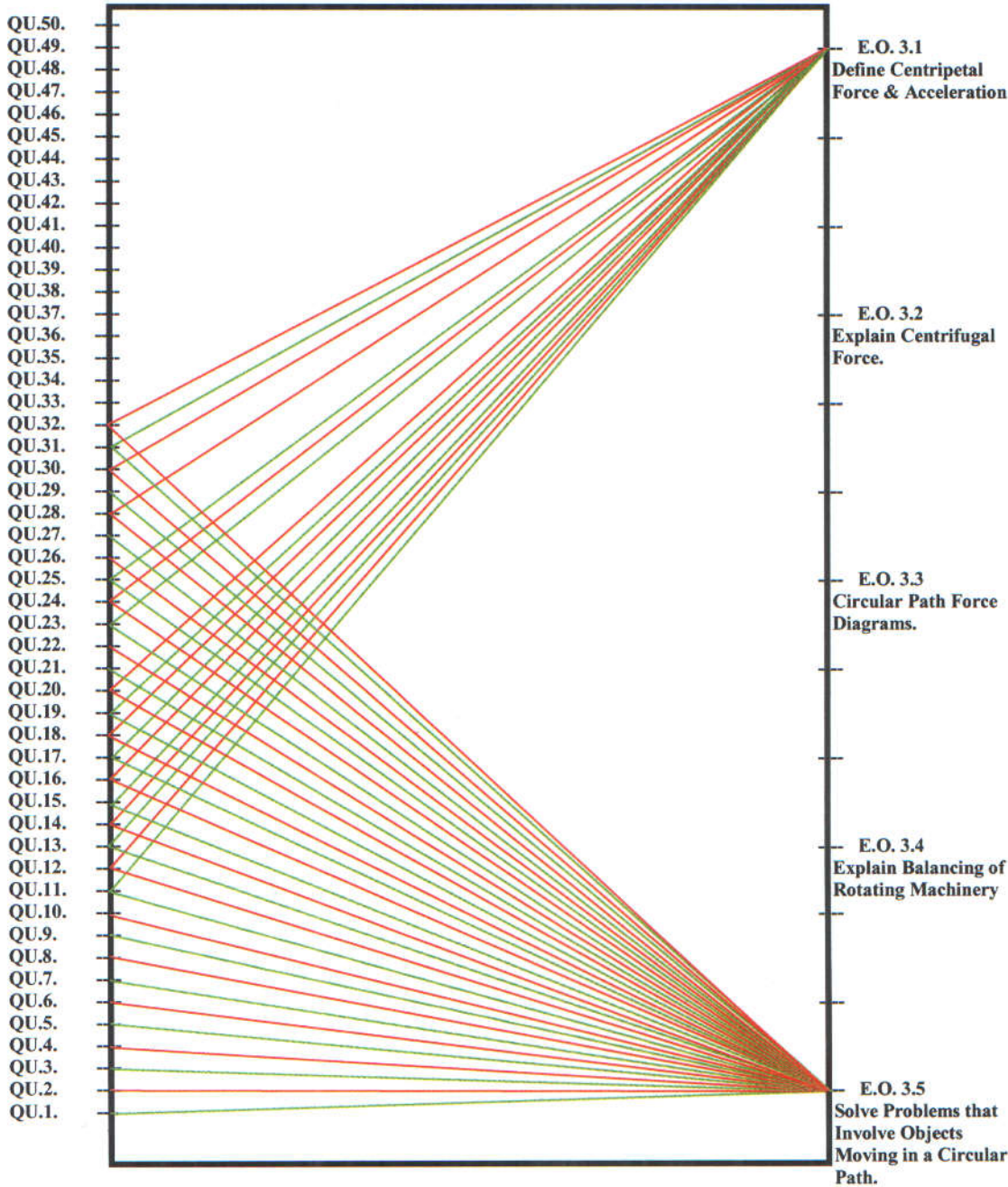


CONTENT VALIDITY – (Assessment Question/Training Objective).



CONTENT VALIDITY – (Assessment Question/Training Objective).

ASSESSMENT
INSTRUMENT: Circular Motion Post Tests. (Eng.Sci).



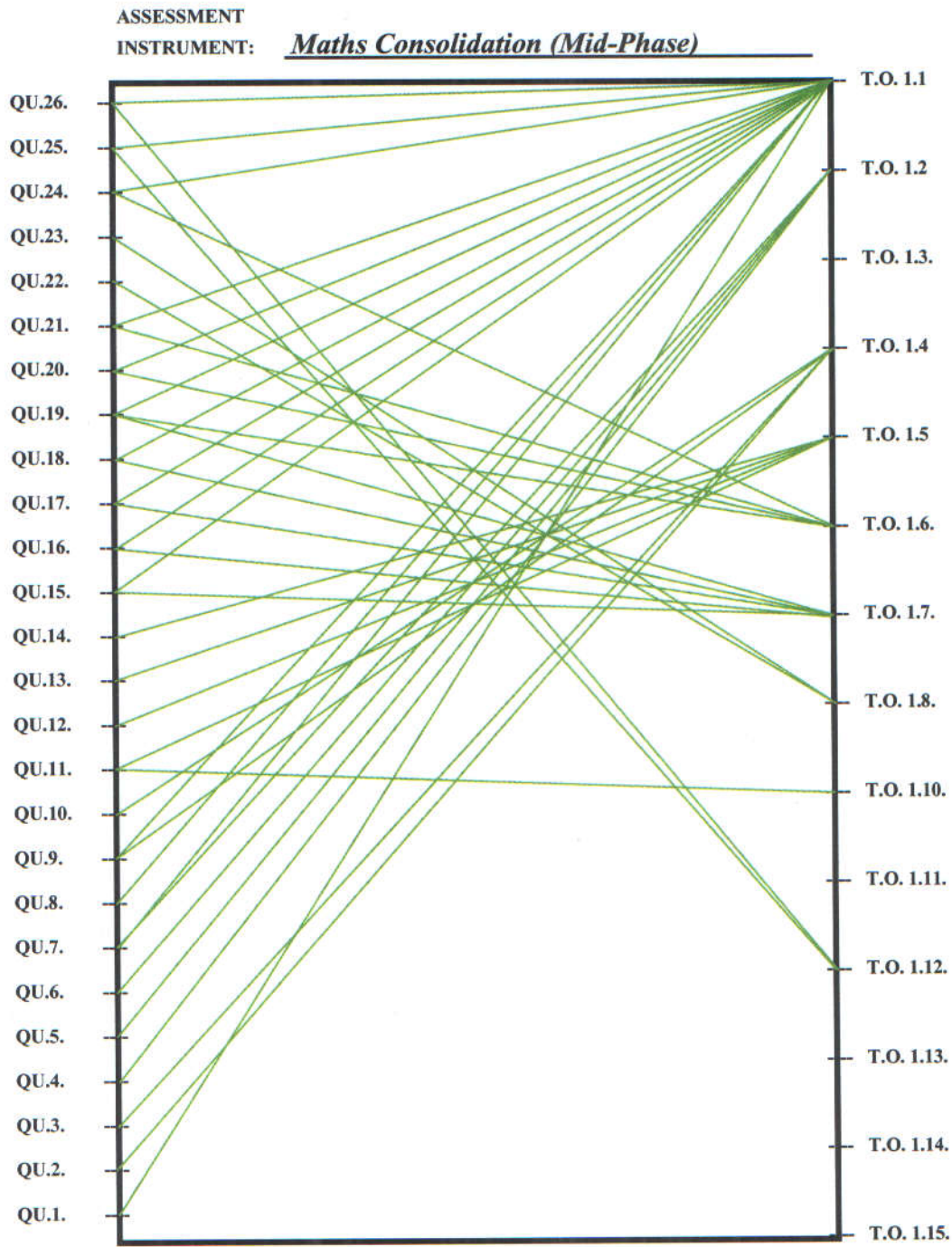
Key to Training Objectives:

- T.O. 1.1. Forces – vectors.
- T.O. 1.2. Forces – friction.
- T.O. 1.4. Forces – moments.
- T.O. 1.5. Shear Force & Bending Moments.
- T.O. 2.1. Motion – velocity.
- T.O. 2.2. Motion – Newton's Laws.
- T.O. 2.3. Motion – circular.

- T.O. 3.1. Energy – conservation.
- T.O. 3.2. Energy – machines.
- T.O. 4.1. Fluids – pressure.
- T.O. 4.2. Fluids – pressure measurement.
- T.O. 4.3. Fluids – incompressible Flow.
- T.O. 4.4. Fluids – flow measurement.
- T.O. 4.5. Fluids – flow forces.
- T.O. 5.1. Aerodynamics – subsonic.
- T.O. 5.2. Aerodynamics – supersonic.

- T.O. 6.1. Gas Laws.
 - T.O. 6.2. Thermodynamics and Fluid Dynamics.
- ENGINEERING SCIENCE.
(Propulsion)

CONTENT VALIDITY – (Assessment Question/Training Objective).



Key to Training Objectives:

T.O. 1.1. – Electronic Aids.

T.O. 1.2 – Decimals, Percentages, Indices & Logarithms.

T.O. 1.3 - Tables & Charts.

T.O. 1.4 – Numbering & Measuring Systems.

T.O. 1.5. – Formulae & Substitution.

T.O. 1.6. – Areas, Perimeters & Mass.

T.O. 1.7. – Surface Area & Volume.

T.O. 1.8. – Graphs & Linear Laws.

T.O. 1.10. – Linear, Quadratic & Simultaneous Eqn's.

T.O. 1.11. – Calculus

T.O. 1.12. – Trigonometry.

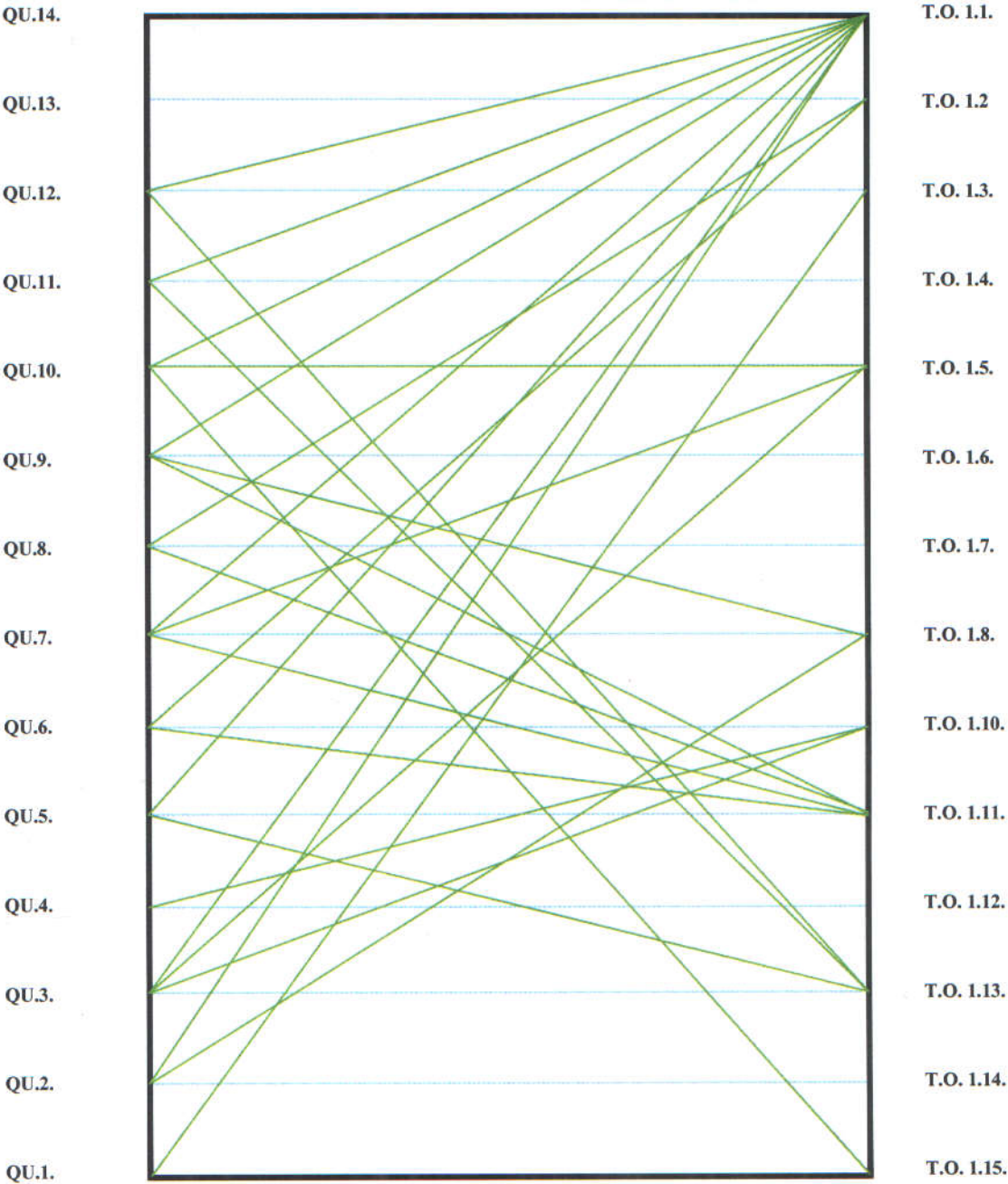
T.O. 1.13. – Vectors.

T.O. 1.14. – Complex Numbers.

T.O. 1.15. – Statistics.

CONTENT VALIDITY – (Assessment Question/Training Objective).

ASSESSMENT
INSTRUMENT: **Maths Consolidation (End of Phase).**



Key to Training Objectives:

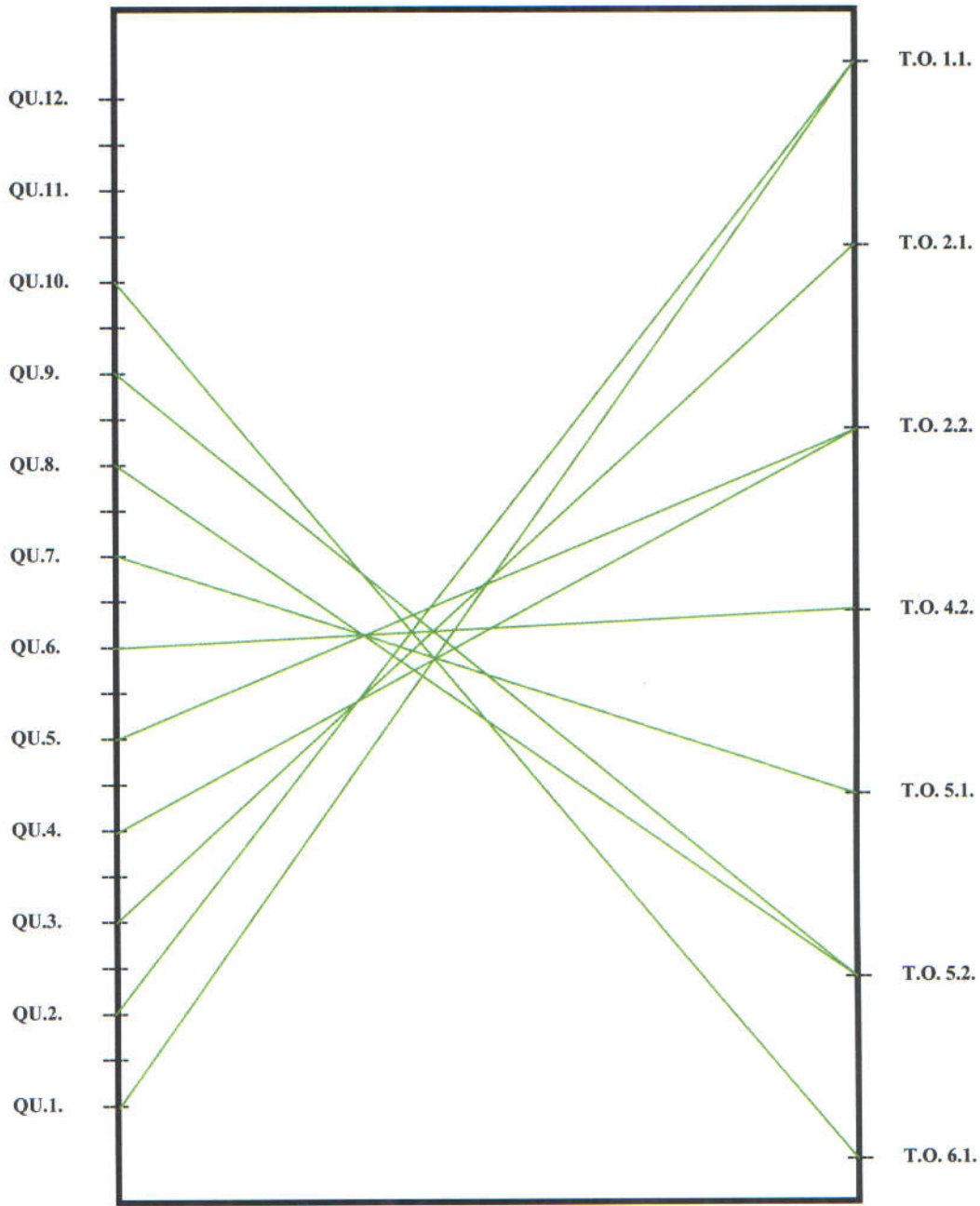
- T.O. 1.1. – Electronic Aids.
- T.O. 1.2 – Decimals, Percentages, Indices & Logarithms.
- T.O. 1.3 – Tables & Charts.
- T.O. 1.4 – Numbering & Measuring Systems.

- T.O. 1.5. – Formulae & Substitution.
- T.O. 1.6. – Areas, Perimeters & Mass.
- T.O. 1.7. – Surface Area & Volume.
- T.O. 1.8. – Graphs & Linear Laws.
- T.O. 1.10. – Linear, Quadratic & Simultaneous Eqn's.

- T.O. 1.11. – Calculus
- T.O. 1.12. – Trigonometry.
- T.O. 1.13. – Vectors.
- T.O. 1.14. – Complex Numbers.
- T.O. 1.15. – Statistics.

CONTENT VALIDITY – (Assessment Question/Training Objective).

ASSESSMENT
INSTRUMENT: Materials Science AB600 Version B.



Key to Training Objectives:

T.O. 1.1. - Structure of Matter.

T.O. 2.1. – Introduction to materials.

T.O. 2.2. – Materials and Forces.

T.O. 4.2 – Creep.

T.O. 5.1. – Polymers.

T.O. 5.2. – Fibre Reinforced Plastics.

T.O. 6.1. – Forming Materials.

Activist (α) Levels 1 – 3.

Student No.	AB100	AB102	AB598	AB602	AB604
A18	P	P	P	P	M
A48	M	P	M	P	P
A50	F	P	M	P	F
A54	P	P	M	P	P
A56	P	P	M	M	P
A59	P	M	P	P	M
P12	P	P	M	M	M
W20	M	M	P	M	P
A5	M	D	P	P	M
A12	D	D	P	M	M
A24	D	M	P	P	D
A26	F	F	P	M	P
A31	D	D	P	M	P
A33	M	M	P	M	M
A47	P	P	M	M	P
A60	P	M	M	P	F
W3	M	M	M	M	P
W8	M	D	M	M	M
W11	P	P	D	M	P
A10	P	F	P	P	F
A11	M	P	P	M	M
A40	D	D	P	D	D
W11	P	P	P	P	M
W16	M	M	M	M	M

Percentage of pass grades = 43.3%
Percentage of merit grades = 40.0%
Percentage of dist.grades = 10.9%
Percentage of fail grades = 5.8%

Reflectors (β) Levels 1 – 3.

Student No.	AB100	AB102	AB598	AB602	AB604
A1	M	M	P	D	M
A13	D	D	M	M	D
A15	D	D	M	M	D
A39	D	D	M	D	M
A46	M	M	P	M	P
A49	M	M	M	D	M
P7	M	P	M	M	P
P10	M	F	P	P	M
P11	M	F	D	M	M
W2	D	M	M	M	D
W22	M	M	M	M	M
W23	P	P	M	M	M
A25	M	D	P	M	M
A29	M	M	P	M	M
A38	D	M	D	M	M
W13	D	M	M	M	M
W27	P	M	M	D	M
A3	D	M	M	M	M
A16	D	M	P	M	M
A37	D	D	M	M	M
A42	M	M	P	P	P
A51	P	F	P	P	P
P16	D	D	D	M	M
W26	M	M	M	P	M

Percentage of pass grades = 17.5%
Percentage of merit grades = 58.3%
Percentage of dist.grades = 21.7%
Percentage of fail grades = 2.5%

Theorist (δ) Levels 1 – 3.

Student No.	AB100	AB102	AB598	AB602	AB604
A22	P	F	P	M	M
A35	M	M	P	M	P
A36	D	D	M	P	P
A53	M	M	D	M	D
W4	D	D	D	M	D
W15	P	F	M	M	P
W17	D	D	M	D	M
W18	M	M	P	M	M
A4	D	D	P	M	P
A7	M	D	M	P	M
A28	P	P	P	M	M
A30	D	D	P	D	D
A52	D	D	M	M	M
P4	D	M	M	M	D
W28	M	D	M	D	M
A19	P	P	P	M	M
A20	P	M	P	D	P
A21	M	P	P	P	M
A23	D	D	M	M	M
A27	P	P	P	M	M
A43	D	M	P	P	P
A44	D	M	P	P	M
P1	M	M	P	P	D
W10	M	M	P	P	D
W19	D	D	M	P	M
W25	M	D	M	M	F

Percentage of pass grades = 29.2%
Percentage of merit grades = 42.3%
Percentage of dist.grades = 26.2%
Percentage of fail grades = 2.3%

Pragmatist (ε) Levels 1 – 3.

Student No.	AB100	AB102	AB598	AB602	AB604
A9	M	D	P	P	M
P3	P	F	M	P	M
P8	M	M	D	D	M
W14	M	M	M	M	M
A6	M	D	M	D	M
A14	P	P	P	P	P
A34	M	P	P	P	P
A58	P	P	M	P	M
P15	M	P	M	P	D
W6	M	M	M	M	M
W29	D	D	P	M	M
A17	P	M	P	D	D
A45	M	M	P	M	P
P5	D	M	D	M	D
P9	M	M	M	P	M
W7	P	M	M	M	D
W9	P	M	M	M	D
W12	M	M	P	P	P
W24	M	D	M	P	M

Percentage of pass grades = 31.6%
Percentage of merit grades = 50.5%
Percentage of dist.grades = 16.8%
Percentage of fail grades = 1.1%

Assessment Grades Awarded to Hub Learners.

	AB100	AB102	AB598	AB602	AB604
A2	M	P	M	M	M
A32	M	D	D	D	D
A41	D	M	P	P	P
A57	M	M	P	M	M
P14	M	P	P	P	M
W5	D	D	M	M	M

Percentage of pass grades = 27%

Percentage of merit grades = 50%

Percentage of dist.grades = 23%

Percentage of fail grades = 0%

Summary & Recommendations

Appendices

DD) Example Question for BTEC (NC) Outcome 'Calculus'.

EE) Example BTEC (NC) Assignment in Experiential Learning Format.

OUTCOME 12 – CALCULUS.

This question is based upon outcome 12 Calculus and carries a weighting of 40% which reflects the syllabus time allocated to this topic. In order to achieve a pass grade you must successfully complete parts a & b. To achieve a merit you must also successfully complete parts c & d. To gain a distinction you must successfully complete all parts of the question. Please refer to the pass, merit, distinction criteria on page 2 of this examination before you begin.

4. a) Differentiate the following and state what the result represents:

(i) $A = \pi r^2$ (With respect to r , where A = area and r = radius).

(ii) $s = ut + \frac{1}{2}at^2$ (With respect to t , where s = distance and t = time).

b) Integrate the following indefinite integrals.

(i) $y = 3x^2 + 2x + \sqrt{x} - 5$

(ii) $v = 4t^5 + 12t^3 + \cos t$

c) Using past data, the law that fits the pendulum experiment was found to be:

$t = 2.006\sqrt{L}$ Where L = String length (m) and t = time period(s)

(i) Differentiate this equation with respect to L .

(ii) Find the value of the gradient when $L = 1.2$ m.

(iii) Find the string length when the gradient equals 0.8.

d) Calculate, using definite integration, the area under the curve, $t = 2.006\sqrt{L}$ between $L = 0.5$ and $L = 1.5$.

e) Discuss the connection between numerical integration and integral calculus, commenting upon:

(i) The results found in questions 3b and 4d.

(ii) The relative accuracy of both methods.

(iii) The suitability of both methods for determining areas.

OUTCOME 4 – CREEP.

- A.
1. Define the terms 'creep' and 'creep relaxation' as applied in an engineering context.
 2. Using the creep machine provided, carry out creep tests on the three specimens provided for this assignment. A 2kg load should be applied in each case.
 3. On suitable graph paper, use the data from part 2 above to plot creep curves for the three specimens tested. The creep curves should all be plotted on the same graph so that comparisons can be made between the properties of the three materials tested.
 4. Show on your graph, the three stages of creep for each of the specimens tested.
 5. Using your graph and the creep test data comment upon the different properties of the materials tested.
- P
- B.
1. Collect your pack of three identical lead specimens from the laboratory technician. Using the creep machine provided and using an identical load in each case, test each of the samples at a different temperature by adjusting the temperature control on the creep machine. (The temperature should vary by at least 3°C for each test).
 2. Using data from the above creep tests plot the three creep curves on a suitable set of axes. (Use a different colour for each creep curve). Write a laboratory report that includes your findings and conclusions from the above creep tests.
- M
- C.
1. Explain how creep problems may be reduced on aircraft. Use your findings from the above tests to help support your answer.
- D